Performance Analysis of Multilevel Clustering Protocol with Energy Efficiency and Reliabilty

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Abstract- Wireless Senor Networks (WSNs) have two critical requirements: lengthy network of lifespan and also end-to-end dependability. The Sensor nodes use larger energy while data communication than they doduring the data detection. In a wireless network, superfluous data increases the energy consumption, delay, reliability while data transmission. As a result, itis even critical to ensure dependable, energy-efficient data transfer in WSN. In this study we also examine, clustered network design, as well as a variety of energy-saving strategies and approaches for assuring packet delivery. Because of its key attributes including low power consumption, scalability, the capacity to respondquickly and reliably, dynamic nature, low cost, and ease of installation, Applications for wireless sensor networks may be found in many different industries. Finding acceptable intra-cluster and inter-cluster communication protocols that are energy efficient, scalable, and reliable is the major goal of this research.As a result, the planned research project involves threedistinct phases. Trio protocols—Energy Efficient and Reliable Clustering Routing Protocol , Energy Efficientand Reliable MAC Protocol, and Energy Efficient and Reliable Hybrid Transport Protocol—are the subject of the proposed research project in order to accomplish the required outcomes (EERHTP). Cluster formation and efficient data transfer are aided by the intra-cluster communication protocols EERCRP and EERMAC. For inter-cluster communication, EERHTP is a transport layer protocol.

Keywords:Clustering,Sensors,Networks,Protocols,Efficiency,Reliability,MAC.

I. INTRODUCTION

Wireless Sensor Network (WSN) is a system for thousands of small, low-cost nodes with limited resources that can intellect an event besides analyzeand communicate sensed information wirelessly. The WSN has several uses, including tracking objects, observing wildlife, monitoring health conditions, controlling industrial processes, automating homes, and maintaining security.[1] As the WSNs are set up in an unattended setting, great dependability is needed for WSN applications. The redundancy of the data has an impact on WSN reliability the gradual change in phenomena or the simultaneous detection of the same data by several sensors are the two main causes of duplicated data in WSNRedundancy in data may beroughly categorized as either geographical or temporal redundancy. Several sensor nodes using the same felt data result in spatial redundancy. Because a sensor node consistently produces the same sensing result throughout time, there is temporal redundancy. The duplicated data consumes more energy from the nodes and adds to communication, computational, and congestion problems. By introducing redundant data, the malicious nodes may exploit duplicate data anddrain energy.

[1,2]Packet sequence numbers in WSNs are used to manage redundant data. This method enables the receiver to detect and remove duplicate data. a sequence number for a packet, however, it cannot assista source in managing the delivery of duplicated data. Another method to get rid of unnecessary information isdata aggregation. For data gathering, the routing techniques may have a structured design, such as a tree- or cluster-based architecture. In structured data gathering, information is composed from many sources besides sent toward an aggregate point, which then removes redundant data using a variety of techniques, including statistical, probabilistic, and artificial intelligence approaches. In order to reduce the energy required to construct a structure, the structure-free techniques carry out dynamic data aggregation utilizing local information

To minimize data redundancy in WSN, data sensing frequency might be decreased. Unfortunately, this can have an impact on the data's accuracy. As a result, the data should be sensed on a regular basis, and handling duplicate data in WSN is crucial. Furthermore, an effective transport protocol mechanism is required to handle the trustworthy datadelivery to the sink node. In this research, we offer a framework for managing redundant data transmission with BS coordination in order to increase network lifespan and guarantee dependability from beginning to finish.

There is a cluster head (CH) for each cluster, which collects comparable information since all of the cluster's associates and sends it to the CH at the next level. The geographic redundancy is handled by this clustering method. By not delivering thetemporal duplicate data to the Cluster Head, the temporal redundancy is managed in the second way. For the purpose of locating duplicate data on its ownside, the Base Station employs a time-out system. In order to provide endwise dependability for all information, it employs both implicit and explicit acknowledgement techniques.

We provide a BS algorithm that calculates and produces an acknowledgment for each piece of data, regardless of whether the data is redundant and not received

II. LITERATURE REVIEW

Several writers have explored in depth a complete overview of WSN, of their architecture, and their mutual standards used aimed at numerous applications.

(Akyildizeetaiol. 2001, Pereilloetloal. 2004 and Heinzaelmanetal. 2002) provides comprehensive introduction to sensing networks, outlining prospective requests, variables impacting sensor networking architecture, standards elect adhered to throughout the network implementation, and networking connection architecture.

[3]To lower network's power use, a number of clustering methods are offered. According to writers (Teixeira et al. 2004, Zeghielet et al. 2009), such procedures approaches are provided. (Ye and Mohamadian 2014) demonstrates how an active routing strategy founded on an Ant Colony optimization approach may extend network life while also using less energy. By using a fuzzy technique for efficiency of Cluster Head (CH) selection besides cluster extent estimation, Nitin Goyal et al. (2016) suggested an underwater wireless sensor network communication paradigm for within- and between-cluster communication (UWSN).The Minimal Average Routing Path (MARPCP) cluster algorithm which is used for the intra-cluster message. Data decrease, load balancing, and the topology control are the three goals of the Cluster-Based Wireless Sensor Networks with Energy- Conscious Multitier Architecture with Data Reduction (ECMTADR) (Taner Cevik 2015). Whenmeasured against LEACH and HEED, it performs best. Using a unique parameter named SCPR prevents data repetition. A CH is selected within each hexagonal cluster as part of the topology construction.

Protocol	Type	Techniques and Access method	Energy saving mechanism
SMAC (John Heidemann 2002)	Contention based (Synchronous)	Adaptive Listening using Fixed Duty Cycle Uses either TDMA or CSMA	Low and suffers from Latency
T-MAC (T.V. Dam 2003)	Contention based (Synchronous)	Uses FTS (Future Request To Send) packets, Uses Adaptive Duty cycle, Concept of Overhearing	High but suffers from early sleeping problem
TRAMA V. (Rajendran 2003)	Contention based (Synchronous)	Adaptive Assignment using TDMA	High
B-MAC (Joseph 2004)	Contention based (Asynchronous)	Low Power Listening	Medium and suffers from the problem of overhearing
WISE-MAC (Amre El-Hoiydi 2004)	Contention based (Asynchronous)	Preamble Sampling, Synchronized	High. Latency at every hop
PRIMA(Ben-Othman 2011)	Hybrid	Queuing model as classifier , TDMA and CSMA	High energy saving under prioritized traffic
PW-MAC (Lei Tang 2011)	Asynchronous	Predictive wakeup	Very high even during multiple traffic flows

III. UTILIZING RELIABILITY MODELS AND PRIORITY QUEUES ,INTER_CLUSTER COMMUNICATION

Avoiding delay for quick information report for dynamic monitor systems as compared to passively tracking systems is one of the most crucial design goals of a dependable system. To prevent jitter and delay, several measures must be used. [4]Data deliveryis influenced by a number of factors in addition to dependability, including congestion, energy use, throughput, and latency.

The best route from the source to the destination should be chosen based on the intermediate nodes' energy status, the reliability of the information, the capacity of the network, the congestion statusmethod, which is typically applied by means of a lineup model, the data composed from the right detectionarea, the method of data broadcast (hop-by-hop or endwise), the choice of an appropriate byline method,and the package header (Kosanovic et al. 2008).

A. RELIABILITY MODELS

[4]For the reliable data transfer in the WSNs, several dependable transport methods have been suggested.These include Pump Slowly Fetch Quickly , Incident to Descend Dependable Transport , Asymmetric Reliable Transport, Rate-controlled Reliable Transport protocol, Flush,Energy-efficient and Reliable Transport Protocol, Data-Reliable Energy EfficientTransport Layer Protocol, and Distributed Caching for Device System. These transportation methods dependability and energy efficiency are examined. It has been noted that energy-inefficient procedures include DTSN, ESRT, RMST, ART, RCRT, PSFQ, and Enhanced PSFQ.

The RMST [5] is a sensors-to-sink Upstream protocol based on NACK that mainly employs timer-driven loss detection and repair methods. Hop-by-hop recovery is used to support dependability. There aretwo operating modes introduced: the two modes arecaching and non-caching. The data segments are cached on the basin node and all intermediary bulges,which also periodically patterned the store for any lost sections. The bulge that discovers lost sections sends a NACK transmission sent along theway back to the predetermined track. The improper station identifies the honesty of the RMST data part of the conventional data while in non- caching mode while source and sink keep the supply.

ESRT[6]seeks to deliver upstream trigger dependability and capacity control with the least amount of liveliness. Moreover, it may successfullytransmit many simultaneous actions to the BS. Onlyend-to-end dependable transmission for a single happening, not a single package since every device node, is guaranteed by ESRT. The quantity of packs conveying data about the certain happening thatremain transported to the sink is used to gaugedependability. The reporting frequency rate is set bythe ESRT to produce the required event detection accuracy with the least amount of energy use.

The ART[8] is made to offer both ahead (sensor to sink) and downward (sink to sensor) request accuracy, or bidirectional reliability. Moreover, it offers a decentralized approach for upstream congestion control and effectively controls the data flow of intermediary nodes. To cover area that be detected in an energy-efficient fashion, subgroup of instrument nodes is identified as important nodes (E-nodes) based on their residual energy. Consistency among the E-node besides sink is ensured via a lightweight ACK mechanism.

An upward multipoint-to-point safe transportation method called the RCRT has functionality for explicit rate adaptation and congestion control. The obvious endwise loss retrieval method used by the RCRT provides reliability. For on-demand loss recovery and end-to-end harm recovery, each node with the track maintains a packet store and uses a NACK-based retransmission mechanism. The sink is responsible for centrally managing rate adaptation, recovery, and congestion detection. TheRCRT supply end-to-end dependability of everyfacts supplied by every sensor to a bowl. Yet, the RCRT dependability is dependent on unproductive MAC sheet retransmission. Due to the dependence of Because capacity monitoring on loss recover time, a simple transmission loss may cause rate drop. Topic of controversy is not covered by the RCRT.

The Flush is a trustworthy end-to-end dependablehigh decent put unpackaged data transportation mechanism. to protect against inter-path interference and to maintain a single data flow, the sinkin Flush round robin agendas the data transmission forrespectively node. The ERTP is an energy-efficient transport procedure developed to offer end-to-end analytical dependability for short data transfering WSN usage. The ERTP[5,7] dependability is identified by theamount of data packets collected at the washbasin as opposed to the dependability of each individual data container. By regulating reliability at every hop, stop and wait hop- by-hop ImplicitAcknowledgement (IACK) for loss recuperation increases energy effectiveness while achieving end-to-end dependability.

With an emphasis on reliability, scalability, and resilience, To solve the unique resource issues of WSNs, the PSFQ dispenses facts hop-by-hop from sensors to sink (downstream). The three protocol operations are message sending operations (pump operation), resident loss retrieval (fetch operation), and careful standing reporting functionalities that develop the PSFQ (report operation). Once each data segment is sent out, the pump operation injects packets slowly intothe network. using a quick fetch operation-based negative acknowledgement (NACK) PSFQ's dependability isattained.

B. HIERARCHICAL ENERGY EFFICIENT RELIABLE TRANSPORT PROTOCOL

This section provides an summary of the hierarchical cluster construction and intelligent data transmission processes, and base station computation of missing redundant data and redundant data that is redundant butnot present.Finally, using a variety of case examples, we provide an acknowledgement technique to attain dependability. By minimizing duplicate data transit via WSN, thehierarchical cluster-based transport protocol with low energy utilization is called HEERTP[6,7]. With the help of the BS, the sensor nodes in the proposed protocol minimize the transmission of duplicate data that has been sensed. Our suggested approach builds a hierarchyof sensor clusters for data collection inside the network.The cluster head is one of the nodes in the group (CH).The CH is in charge of gathering data for the group andtransmitting it either directly to BS or via a chain of CHs to the BS. The nodes' remaining energy and coordinate location are used to select the CH. Theworks offers several strategies for choosing a CH, leader, or root. In WSN, the cluster creation uses a largequantity of energy. To avoid the computational complexity, the suggested methodology adopts a straightforward cluster building technique.

The assistance of BS helps the HEERTP[6] create clusters at various levels. In the cluster hierarchy, the leaf nodes convey sensed information to CH. The Cluster Head sends the information it has acquired to the CH above it, and then CH closest to BS sends it to Base Station. We refer to the Cluster Head at top of thehierarchy and closest to the BS as root level cluster head (RCH). BS is permitted to choose an RCH in order to lessen the cluster formation overhead. Maximum hopcount value (Mhc), a parameter likewise calculated by the BS, regulates the degree of cluster formation.

$$M_{hc} = (D/d) - 1$$

where the D is greatest allowable separation amid two endpoints of a device field and d is the sensor node's broadcast range. If the whole sensor arena can be contained within a rectangle, then D is rectangle's sloping and is calculated as $\sqrt{(x^2+y^2)}$, wherever x and y are the binary edges of therectangle. D may be regarded as the diameter of the circle that presents in the sensor field in the situation of a spherical device field.

Diagrammatic representation[8] of the core concept of level-wise cluster is shown. At the sensor level,the sensor nodes are dispersed at random. We assume that at the moment of node deployment, adevice node is alert of both its own and the BS's coordinate positions. The nodes that absorbed in joining the RCH determine how far they are fromthe BS. As stated in step 1, the sensor node sends a request message to the BS. If the calculated distance (dNiBS) is closer than sensor node'stransmitting range (tr). The request message includes the base station ID, distance, sensor nodeID, and battery power remaining information (Resbattpow) (BSID). The BS determines the each requesting node's battery power to distance (q) ratio.RCH is chosen as the node with the highest value of q. As seen in step 2, the base station acknowledges the selected RCH in response.

BSID, SNID,[7,8] a hop total number are contained in the acknowledgment (ACK) packet. RCH reduces its hop count value by one from the hop total received after getting an ACK packet. Tocreate the cluster depicted in step 3, RCH node transmits the ad communication to its nearby neighbors that are in its radio range. In the advertising message are the ClusterHead ID (CHID), Location, and hop count. The origin level bunch head's ID is CHID during period of root level cluster formation. The CH or RCH's advertisement messages one shorter than its own hop count was set as the hop count. At step 4 of, nodes in RCH's surrounding region that opt Send RCH ajoining message to join the cluster.

This RCH[9] creates a cluster that is also referred to as a primary order cluster, one hop cluster, or a origin level cluster. Step 5 shows how to establish next level clusters by having non-cluster head nodes send CH advertising messages once more rootlevel cluster creation is complete. The ad message has the same fields as those mentioned before in RCH. It is possible for a node to receive several cluster advertisement messages. A node selects the CH with the fewest hops and the highest hop count when it gets an advertisement message frommore than one CH. While receiving advertisement messages, a node choose to connection a cluster whose hop count price is the maximum is highest because the closer a node is to the base station, the greater the value of the hop count. The node chooses a node at random from the received advertisement messages if it gets several cluster advertisements messages with the identical hop count number. The second ordercluster, or two hop cluster, is formed by nodes sending joining messages, as shown in step 6.This procedure is repeated until the cluster hierarchy and all of the network's nodes have beenformed. The hierarchy of cluster creation is seen in stages 7 and 8. After a certain amount of time, if a node has non received any advertising cluster messages, the situation attempts to locate closest bunch and join it by gradually extending its radio range. The algorithm used during the cluster creation phase is depicted. The BS broadcasts a control packetto start the re-cluster creation. When the BS gets a Re-clustering control communication from the RCH is started by the RCH. Resbatt pow 6 2 sends the controlmessage to BS.

$$Th_{energy}=\min(S_{energy})+T_{req\ energy}$$

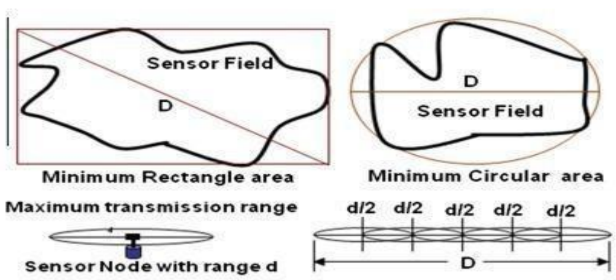

Fig 1 maximum necessary hop-count estimation in the sensor field.

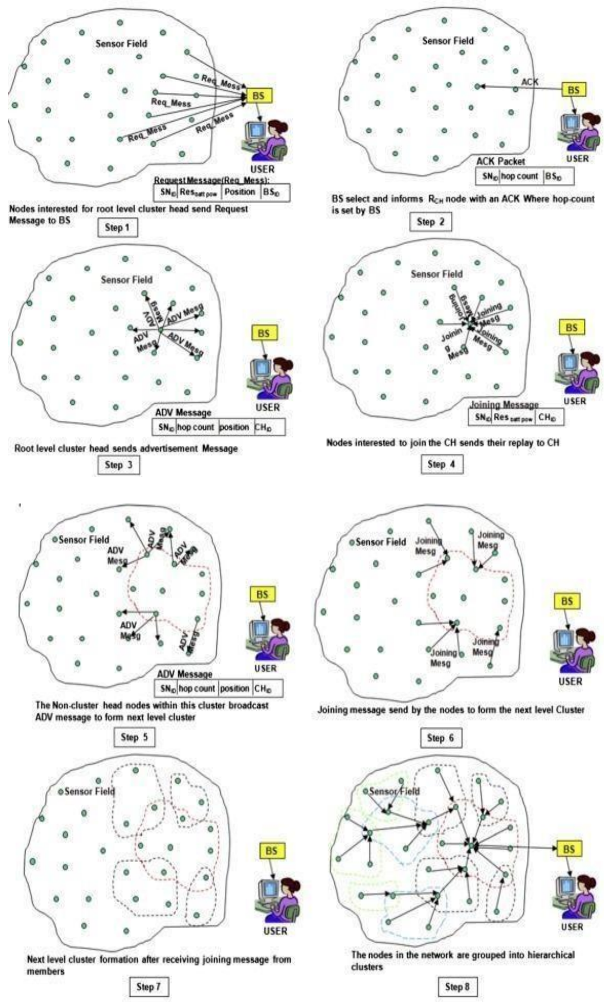

Fig 2 Creation of clusters in a sensor field.

IV. ALGORITHM FOR EERHTP USING RELIABILITY SCHEMES

A. VARIABLES:

Data Packet DPin

Priority Queue PQ

Base Station BS

ACK Acknowledgement

NACK NegativeAcknowledgement

B. ALGORITHM:

Step 1: Follow steps (2) through (7) if DPin is true; otherwise Steps (8) to to be followed if DPin in NPQ (9)

Step 2: Set the step counter's initial value to 0.

Step 3: Use a suitable routing technique to send DPin to the next hop node and then Addone to the step counter's value.

Step 4: Excluding duplicate of DPin in intermediate node's barrier.

Step 5: Repetition of the Steps 3 and 4 will getfor DPin into the Base Station.

Step 6: As soon as DPin reaches BS, BS sends an acknowledgement to the intermediate nodes. This procedure continues until the source node receives the acknowledgement.

Step 7: Retransmission of the data from the prior intermediate node in the event of ACK loss; else, return.

Step 8: Send DPin to the next hop node leading to the BS using a suitable routingtechnique.

Step 9: Send NACK to the source node if BS doesn't receive DPin within the allotted time.

Step 10: Go back.

C. PSEUDOCODE FOR HIERARCHICAL CLUSTER FORMATION:

```
Algorithm Cluster Formation()
Executed at the sensor node
begin:
   interested nodes N_i to be a R_CH computes d_NiBS ;
   if(d_NiBS < t_r)then
     transmit(request message);
   else
     wait;
   endif;
   if(receive (ACK CH)= true)then
     set hop count = M_hc - 1;
     transmit(advertisement message);
     if(receive(join message)= true) then
        store SN_ID and co-ordinate;
     endif;
   endif;
   if((member (cluster)=true)and (!CH)) then
     set hop count=hop count-1;
     transmit(advertisement message);
  else
    if((member (cluster)=false)and (!CH)and
        (receive(advertisement message)=false) and
        (time out()=true)) then
        find a CH and join it;
    else
       if((member (cluster)=false)and (!CH)and
        (receive(advertisement message)=true) and
        (time out()=true)) then
         selects the advertised node as CH and join it
     endif;
   endif;
end;
```

```
Algorithm Cluster Formation_BS()
Executed at the Base station
begin:
   initialization Th_energy = min(S_energy)+T_req energy ,d= t_r;
   compute D from sensing field;
   compute M_hc = (D/d)-1;
   select RCH();
   set hop count = M_hc
   transmit (ACK CH);
   if(Res_batt_pow <= 2* Th_energy)then
     initiate cluster formation();
   endif;
end;
```

```
select RCH()
begin:
   for i=1 to N
     compute ratio (ρ) as Res_batt_pow to d_NiBS
   endfor;
   select Node_i with max (ρ) as R_CH;
end;
```

D. PSEUDOCODES OF THE FUNCTIONALITIES AT SENDER SIDE:

```
Algorithm Data_Gathering( Res_batt_pow )
begin:
  initialize Th_energy= S_energy + T_req_energy , pseq_no=0;
  initialize prevdata=∅, read_data=∅, node_th_count=0,th;
  while(Res_batt_pow >= Th_energy) do
     read_data = sense_data();
     if(valid_data(read_data)=true)
        transmit_data(read_data);
     else
         set node_th_count= node_th_count +1;
         set pseq_no= pseq_no +1;
     endif;
  end while;
  if ( ACK_NO!=pseq_no) then
       transmit_data(read_data);
     endif;
end;
```

```
valid_data(read_data)
begin:
      if((prevdata = ∅)or(read_data ≠ prevdata) or
                                       (node_th_count=th))  then
          Set prevdata=read_data;
          set  pseq_no=0;
         node_th_count=0;
         return true;
      else
          return false;
      endif;
end;
```

E. PSEUDOCODE OF THE FUNCTIONALITIES ATBASE STATION:

```
Algorithm Data compute(received data )
begin:
     initialize rdata= received data, time counter=0, time=0;
     if((rdata ≠ current data)or ((rdata=current data) and
                                   (time counter>th))) then
          set current data=rdata;
          set previous data=current data;
          set time counter=0;
          set  pseq no=0 ;
          generate ACK 0;
          Last data received time = current time();
     else
      if ((!received data )and(time counter<=th)) then
           set current_ data=previous_data
           set time counter=time counter+1;
           set Last data received time= current time();
           set  pseq no= pseq no+1;
           generate ACK (pseq no);
      else
        if ((rdata=current data)and(time counter<=th)) then
            retransmit the ACK(pseq no);
        else
            if(( !received data)and(time counter>th)
              send control packet to check status of the node
              if no replay from the node then
              set node status =dead;
            endif;
          endif;
        endif;
      end if;
end;
```

V. RELIABILITY MODEL

The acknowledgement verification phase is oneof the most crucial steps in ensuring the sensor side's dependability. The acknowledgment number and packet sequence number are cross-verified at this step. The node verifies that the transmission was successful if both numbersmatch. If not, the detected data is sent again. Data is hierarchically resended from the CHs when a packet is lost in BS. In the event that CHs are unable to resend the data, the data is retrieved from the basis node.

In this case, procedure uses middle caching similar to DTSN. Data packets are stored by the CH and retransmitted when necessary. This step assists in overcoming the issue of package loss and achieving endwise dependability with the least amount of above. With the retransmission of missed packets and the suppression of NACKs, the CH lowers traffic overhead. In order to comprehend loss recovery and preserve dependability, we take a look at a few different scenarios while presuming that th has a value of 5.

CASE 1: IACK/EACK[10] actions for the normal flow acknowledgment A fresh sensed data's pseq number is usual to 0. The detected node sends information to BS through many CHs. Animplicit acknowledgement is sent to the downstream CH or when CH sends informationto the upper CH, the sender (IACK). When getting the information, the BS provides an explicit acknowledgement to the RCH. The acknowledgement procedures for normal flow are shown in Fig. 8. The redundant packets' pseq no. is 1, 2,..., 5, and the EACKs are numbered 1, 2,..., 5, respectively. The sixth redundant data packet's pseq no is set to 0 and new data is sent in the packet.

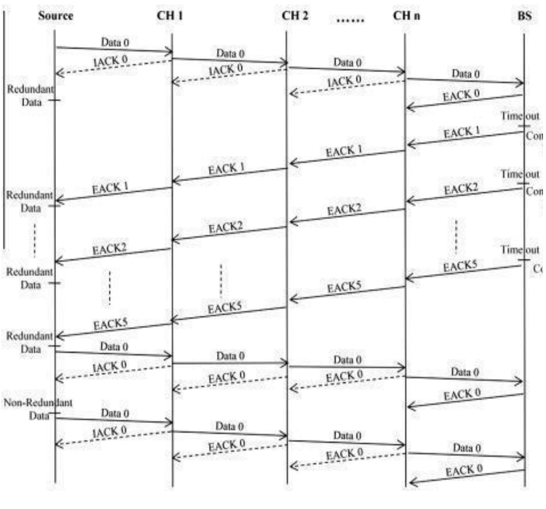

Fig3 Acknowledgement (IACK/EACK)operations for the normal flow

CASE 2: [11]Repeated packet losses from the origin tothe CH and the CH to the base station following the initial loss: Here, we consider a case in which aredundant data packet is misplaced after a predetermined amount of time. After disregarding duplicate data for five times, A pseq number of 0 isused to convey the sixth redundant piece of data to the CH.

The jobless data damage after th times is seen. IACK of the sixth redundant data packet will not be received if When being transmitted from the source to the CH or from one CH to extra CH, it is lost.As a result, following the timeout, Data is resent from the sender or CH to the upstream CH.

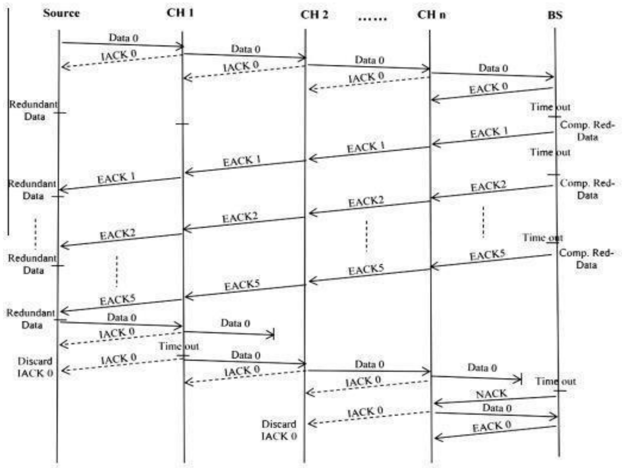

Fig 4 Effects of redundant packet loss when time threshold is exceeded

Case 3: [13]The effect of ACK loss for duplicate datais seen in Fig. 10 (case 3). The sensor does not sendduplicate data to the BS when it detects it. After thetimeout, the redundant data is immediately assumed by each CH along the path from the sender to the BS, and they all store in cache. For redundantdata, the Base Station sends sender the EACK. CHkresends EACK received from the BS if The downstream link (CHk, CHk1) loses the EACK after the CHk1 transmit a switch packet with any non- zero arbitrary pseq Number.

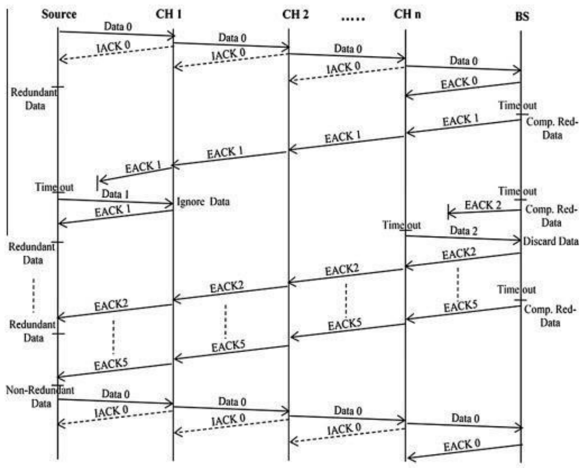

Fig 5 Loss of ACK and effects

Case 4: [14]Non-redundant data impact from packetloss: It illustrates the effects of non-redundant information loss during broadcast. After IACK timeout, sender retransmits the packet if data inside the sender and CH is lost. An EACK witha new sequence number is transmitted by the BS if the packet is lost there as well, presuming thedata to be redundant. Instead of retransmitting the redundant information packet, the RCH rejects the EACK.

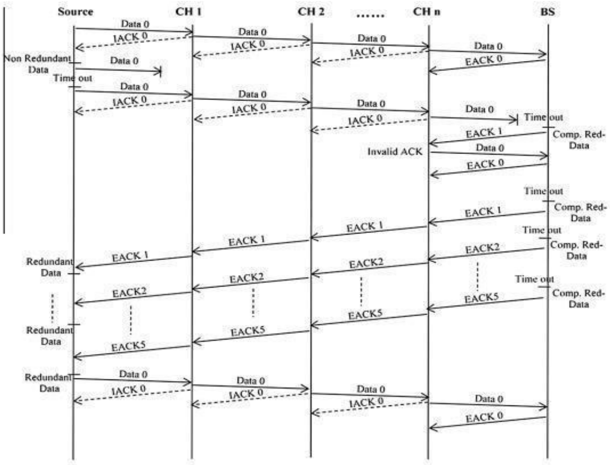

Fig 6 Impact of packet loss for non-redundant data

IV. PERFORMANCE ANALYSIS AND RESULTS

Based on the ACK and NACK model, liveliness and dependability metrics are assessed for EERHTP. The outcomes are tallied, and a comparison graph displays the effectiveness of several indicators.

Parameters	Value
Number of nodes	100
Simulation time	150ms
Area Size	500 X 500 m
Buffer Size	15 packets
Sending gap	25ms
No of packets created	100 packets

Table 1.1 Simulation Limits for EEERHTP

Simulation Time (ms)	Total Energy Consumption (Joules)	
	ACK Model	NACK model
50	156.498	100.67
75	357.306	290.153
100	553.46	485.017
125	733.612	675.022
150	930.519	870.191

Table 1.2 Total Energy Ingesting in EERHTP

Simulation Time (ms)	Average Energy Consumption Per Node (Joules)	
	ACK Model	NACK model
50	1.58079	1.01686
75	3.60915	2.93084
100	5.5905	4.89916
125	7.41022	6.8184
150	9.39919	8.78981

Table 1.3 EERHTP's averaged energy used per node.

Simulation Time (ms)	Packet Drop	
	ACK Model (ms)	NACK model (ms)
50	118	69
75	237	199
100	297	255
125	349	295
150	388	346

Table 1.4 Comparision of packet drop EERHTP

Simulation Time (ms)	Network Routing Overhead	
	ACK Model	NACK model
50	7.19677	8.18171
75	4.52446	4.44182
100	3.99175	3.80444
125	3.59036	3.51283
150	3.4432	3.34255

Table 1.5 Networking Transport OverheadComparisons for EERHTP

Simulation Time (ms)	Throughput	
	ACK Model	NACK model
50	331.846	278.049
75	428.048	423.141
100	446.262	454.364
125	483.311	479.081
150	485.945	490.573

Table 1.6 Comparison of Throughput for EERHTP

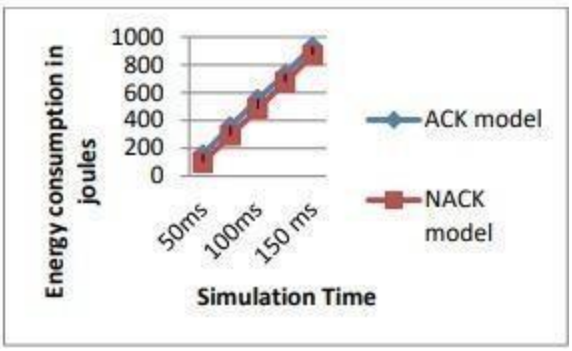

Fig 6.1: Energy Consumption in EERHTP

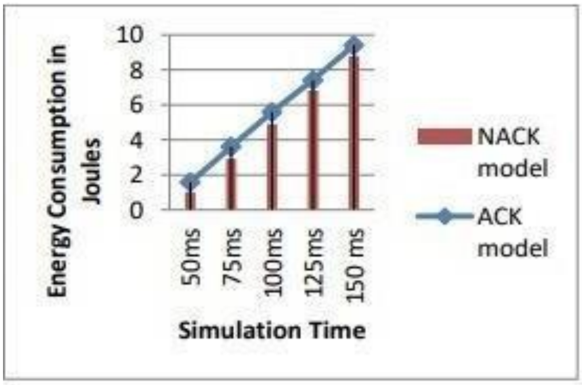

Fig 6.2: Average Energy Consumption for EERHTP

Fig 6.3: Packet Drop Vs Simulation Time

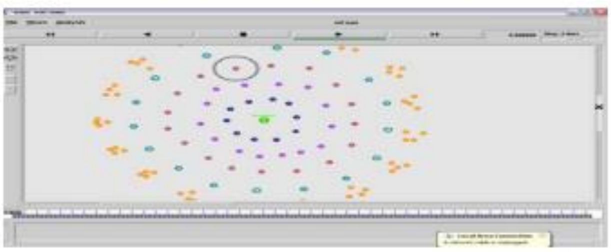

Fig.6.4 Node in a flat layer selected for data forwarding

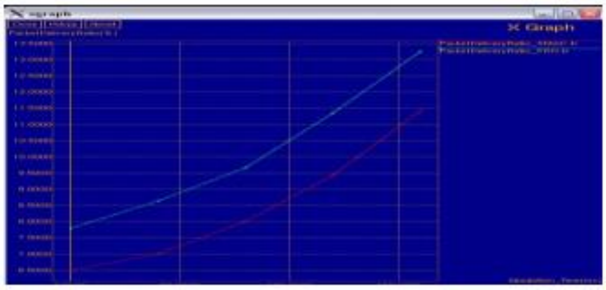

Fig. 6.5 Cluster Head aggregating the data from the Cluster Members

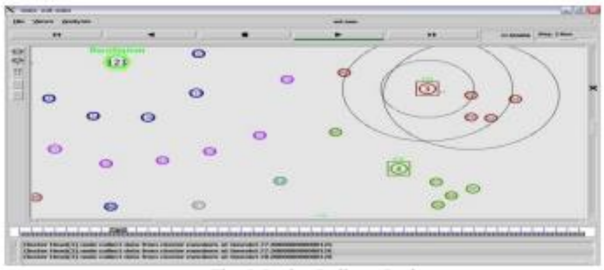

Fig. 6.6 Packet Delivery Ratio

VII.CONCLUSION

Here in research, we provide a outline for wireless sensor network information transmission that is both reliable and energy-efficient. By combining redundant information at CHs, the suggested framework creates a cluster-based structure to handle geographic redundancy. With the help of the BS, it also minimizes the broadcast of the temporally redundant being data, and BS caneven identify redundant information not being received since the device node. When a timeout occurs, the suggested approach locates redundant information at being of receiver side. The receiver changes the data table if it gets non-redundant data. For redundancy checking, respectively period a data point is detected, one contrast is needed.

Thus, the method used at the sender side has an O time complexity. Similar to this, the receiver side's method checks the packet sequence number with the time counter to generate acknowledgements, and as a result, has an O time complexity. For end- to-end dependability, we included both implicit andexplicit acknowledgement. By simulation studiesof the proposed protocol's performance, it has beenfound that our procedure achieves improved than the alternatives in relations of energy efficiency andpackage delivery ratio.

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