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Energy-Efficient Routing for Performance and Network Lifetime Enhancement in Wireless Sensor Networks

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Abstract :-

Due to the rapid and quality advancements in the sensor technology and the availability of stumpy cost hardware, the development of Wireless Sensor Networks (WSNs) has emerged as a unique solution. These networks are the composition of source controlled nodes that are wireless, through which the scalar and multimedia data can be sensed, acquired and transmit from the surroundings. However, the resource controlled character of the wireless sensing devices has made the WSNs to face numerous challenges. A multiplicity of WSN applications are underwater, mountain-based, and forest driving. Practically it is not achievable to revitalize or re-establish these nodes throughout the task. To tackle these challenges, efficient energy utilization is a significant confront in these types of networks, as the node energy is constrained. Thus, these available resources of the node must be utilized efficiently for various basic functions like data sensing, processing and transmitting. So, the energy efficient routing protocols are the key factors to decrease the energy consumption and lifetime elaboration of the network. The Cluster-based routing is a widespread method to attain network performance with energy efficiency to enhance network lifetime. Thus, this work gives the development of routing protocol with efficient energy to elaborate systems lifetime. Performance results indicate that the projected work improves the performance.

Key Words: Energy-Efficiency, Wireless Sensing Devices, Wireless Sensor Network (WSNs), Network Performance, Routing, Cluster-Head, Cluster-based routing.

I. Introduction

WSNs are comprised of spatially distributed sensing and detecting nodes fond of to the sensors in the network for maintaining various states of the deployed region. These nodes are operational with constrained resource batteries. Due to its dispersed temperament, WSNs put forward ease of access to tiny detecting nodes to sense the contiguous information. This type of networks uses multi-hop technique to broadcast the data to the far away nodes from its contact range through its neighbor nodes. A variety of applications are, forest driving, underwater, and mountain-based, so it is not feasible to refresh or reinstate these batteries all the way through the obligation. Accordingly, efficient utilization of energy is a considerable confront in these networks, as node energy is constrained [1]. So, the available resources of the node must be utilized for various basic functions like data sensing, processing the sensed data, and transmitting the processed information. The Routing protocols are the key considerable factors to reduce the consumptionof energy and enhance the network lifetime as well. Moreover, Cluster-based routing is a widespread process to achieve the network performance and to enhance the network lifetime [2].

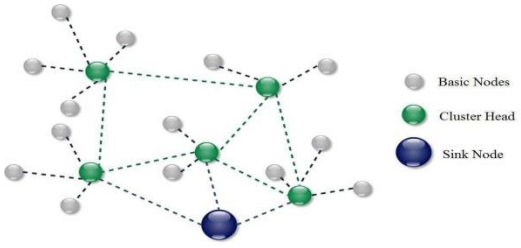

Figure 1: Basic communication Architecture of Wireless Sensor Networks

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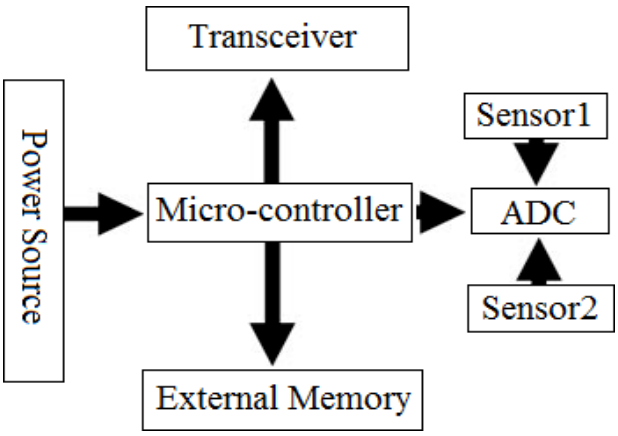
Wireless communication technology in WSN contains two types of communication methodologies i.e., Wireless transportation based communication model and wireless transportation-less network communication model [3]. Wireless transportation based communication model contains wireless movable nodes and permanent nodes. The wireless movable nodes exchange the information data with fixed nodes through pre-established transportation [4]. The wireless transportation less system communication model is nothing but wireless MANETs which contains movable wireless nodes spread in the radio communication region and they communicate with each other through relying on in-between node i.e., with lacking transportation and thus WSN has to perform as a peer to peer network. However, contact among communicating nodes is very challenging due to the features of WSN. Moreover, wireless movable node working in a network has restricted with power batteries and it



is not probable to recharge the energy of the batteries during the given task [5].

Figure 2: Routing Strategy in Wireless network

Applications of WSN mainly include military, healthcare, natural, household & commercial areas in addition to disaster recovery. Due to its variety of features, WSN is paying attention by the majority of the researchers and hence the group of routing protocols has been intended basedon considering diverse parameters. One of those routing protocols is "energy aware routing protocol based on the reactive status of movable nodes" [6]. This work present the state of art performance analysis of "energy aware routing protocol based on the reactive status of mobile nodes" designed for wireless networks. However, it is a lot demanding to justice the current position of routing protocol for the particular network state. In future, the motivation is to split the network state into different categories and after that evaluates the different routine metrics. Based on present investigation parameters such as delivery of packets, the lifetime of the network, and end-to-end delay our work performance is analyzed with the help of network simulator2 (NS-2) [7].

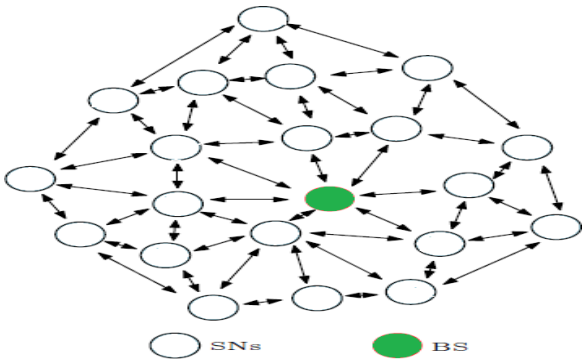


Figure 3: Fundamental Structure of Sensor Node

Furthermore, the performance grades of our work can be used by researchers for their future research. Even though a lot of research efforts carried out within literature in the direction to calculate the performance of dissimilar routing protocols for WSN based on different network circumstances, this work contains performance investigation metric as the lifetime of the network, delivery of packet, overhead and delay (end-to-end). Furthermore, these metrics extremely suitable to calculate the execution of energy-aware routing protocols used for WSN [8]. Living and sleeping pattern reformation is the applications in the home environment. The sink node is outfitted with a adequate amount of processing and battery capabilities, but sensor nodes are outfitted with the

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limited battery and processing capabilities. The energy depletion of any sensor node directly affects the sensing coverage and thereby on the network performance. Moreover, the neighbor node exhaust almost immediately due to the energy depletion. Thus the sink position should be in an appropriate location and is a reasonably fundamental design issue that influences the performance of the network. This paper designs a proficient mechanism for deploying the sink to a suitable position [9]. Finally the sensed information is transmitted to the sink in single or multi-hop contact approach.

The paper's remaining part is prearranged as, the 2nd Section will discuss regarding Efficient-Energy Based different routing protocols in WSN. Furthermore, the part 3 provides the performance assessment of the proposed work. Finally the work is accomplished in fourth and final part of the work.

II. Literature Survey:

The Power effectiveness acts as an important role in sensor networks, spatially in wireless networks like WSNs. These networks are composed of geographically scattered independent nodes in addition to the wireless sensors to sense, and retain various physical and ecological states. Hence, for making efficient data transmission it is very essential to make energy stability in the network for making data transmission efficiently. It will enhance the performance enhancement in the network [10]. Thus, the energy-balancing techniques are required to provide a link with proficiently routing the data in the network within minimum power consumption. Hence, clustering is one of the best ways to balance the overall energy. Furthermore, the cluster head can further improve the network performance by the properly maintained status of the energy. The existing algorithm selects the head node of the cluster based on the remaining power status. Therefore, it is very essential to preserve these parameters to improve network performance [11].

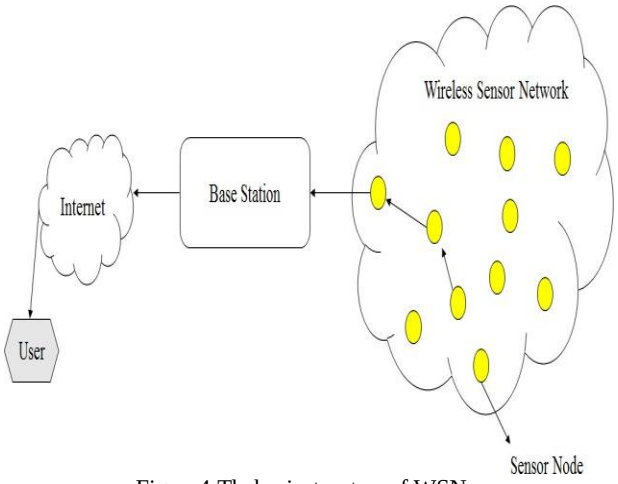

Figure4:Thebasicstructureof WSN

The Wireless networks structure shows that the independent sensor node linked with each other for maintaining and detecting the environmental and physical states of the given application. The energy source of these nodes is outfitted with limited energy. Hence, efficient energy utilization is a significant challenge in these types of networks. Thus, routing techniques with energy efficiency are needed in corporate operations of this network to provide the connectivity and data broadcast in a network with minimum energy consumption. So, routing protocols are one of the key considerable factors to minimize the consumption of energy and lifetime enhancement. Thus, the development of routing protocol with well-organized energy to elaborate systems lifetime is proposed by selecting a proper route [12].

The projected protocol computes the routing

metric based on the current energy status of the intermediate node. To propose an absolute

perceptive of energy-aware routing, the various protocols are developed for wireless networks and superimpose for the forthcoming investigation. Based on the performance parameters those are analyzed for instance packet delivery, network lifetime, and delay [13]. The proposed work implemented through the NS2 (NS2.34/2.35 version). The outcome shows that the proposed

work performs well in contrast with the existing works in WSNs simulator. The result shows the proposed work performs superior than the present protocols in terms of Lifetime and Performance of the wireless network. The calculations are done by the well-known algorithm (known as Knapsack algorithm) [14].

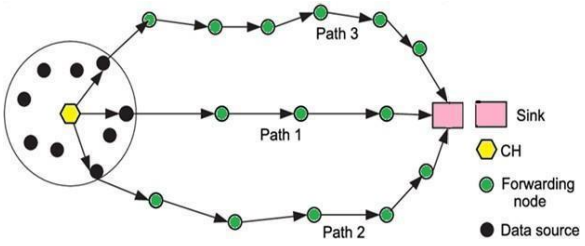

Figure5: DifferentroutingpathsinWSN

III. PROBLEM IDENTIFICATION

To recapitulate, the energy consumption of the nodes can be minimized in two ways; by the hop-alert method and load fair routing mechanism. In the hop-alert method the total amount of energy consumed is minimized during the idle time. In load fair routing mechanism the number of communications are minimizing per node.

- An understandable transaction exists for every sensor nodes in the field, on one hand, it should be activated to provide more sensing abilities; on the other hand, time to save energy it should be kept in an inactive for the longest possible time.
- Till now there is no mathematical tools are developed so far in which maximum lifetime and effect of hop alert on network lifetime investigated.
- The existing techniques are not able to determine the best possible amount of packets that to be routed on each link of the network by considering inactive mode energy consumption for utmost network lifetime.

Routing is the methodology to discover the path/route among communicating nodes, in addition, to transmit the information data throughout the selected path in the form of packets. The main feature of routing is to select the path between the communicating nodes and to keep up the path up to the successful transmission of the information packets. In WSN, routing protocol appearances an additional overhead in contrast by means of wireless transportation based sets of connections, due to its features such like mobility, heterogeneity within the movable nodes, the lack of an intermediate controller and peer to peer system. Furthermore, several routing protocols developed in WSN based on various frameworks, attributes, and features of the network. Utmost of the available routing protocols in WSN considered based on a variety of patterns consequently as to manage with network features of WSN [15]. One of the major challenges in WSNs is efficient- energy routing, since its applications are built-in disaster assistance, military, and health care. Throughout the assignment application, it is not at all possible to recharge or put back the battery. Various routing protocols designed are discussed in literature survey taking into consideration that the energy of the wireless nodes in WSN. Out of that one such routing protocol is “energy aware routing protocol based on the reactive status of mobile nodes”. The intention of the development of this routing protocol is to expand lifetime as well as to achieve energy-efficiency of the network in the system [16]. The routing protocols, which are designed based on energy awareness i.e., selecting the routing path, connecting transmission nodes through the nodes which have utmost left over power or greatest residual energy, are reserving the several of the wireless nodes intended for transmission of the data information due to their higher remaining energy [17]. This condition in the network known as blockage transitional node and bottleneck intermediary node drops the packet due to two reasons such as each of the wireless nodes does not have enough buffer to hold the traffic or its processor does not support the incoming packets in a transitory approach. Figure 1 show the bottleneck intermediate node's situation, in this node 4 becomes a bottleneck node [18].

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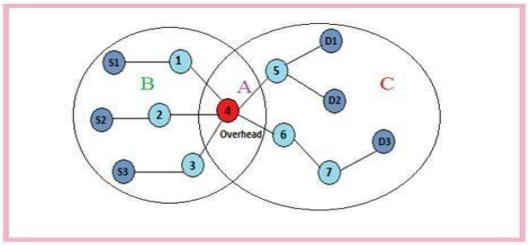

Figure6:Scenarioofnodebecomingbottleneck(node-4isabottlenecknode)

In this work, energy efficient protocols developed for WSNs and classified them to obtain an ideal solution. The substitute to above energy-aware routing protocols is "energy aware routing protocol based on the reactive status of mobile nodes". This protocol is designedbased on the existing position of a transitional node concerning its energy as well as the buffer. Furthermore, while choosing a routing path, this protocol checks the position of each transitional node reactively concerning nodes energy as well as the buffer [19]. Therefore, due to the blockage or bottleneck transitional node it drops the packet. To overcome the scenario of a bottleneck intermediate node, it defined a new route scheme metric which is called as "residual status of intermediate node regarding energy and buffer". This metric is calculated by a multi-objective optimization technique. The two main objectives are remaining power and energy to transmit the information packets [20]. It calculates the metric by the knapsack algorithm in equation-1 i.e. "residual status of transitional node is concerning energy as well as a buffer".

Each node in a system outfitted by means of a battery with energy $'E'$ joules for processing the packet $'PE'$, a buffer with a capability of $'B'$ to hold the packets $'PB'$. Throughout the time period$'t'$,letanyone$'$i$'$packetthroughoutthesensornode,whichconsumesalimitedamount of energy as well as utilize properly the buffer size as well. Subsequently parameters of the nodes, like "Er" the remaining energy and nodes residual buffer "Br" become as follows,

$$=P\mathrm{E}-P_{\mathrm{ei}},P>Pe\mathrm{i}\ldots\ldots\ldots 1$$

$$Br=P_B-P_{b\mathrm{i}},P_B>P_{b\mathrm{i}}\ldots\ldots\ldots\ldots 2$$

The point at which the node will drop the packet is the packet processing capability of thenode withoutdroppingit, in available energy andbuffer[21]. Itcan be computedbysatisfyingthe below situationthroughthe assistance ofknapsackalgorithm,

1. Processingofpacketsshouldbe done withintheremainingenergyandbuffer
2. Theutmostpacketshouldbeprocessedthroughthenode
3. Fractionorpartofthepacketmustnotbeprocessed,itwillbelieveasanillegalcondition

"Optimized ability to restrict packet drop" metric designed by remained energy as well as aleftover buffer of the target node. Annotation considers in this work is specified inside thetable1.Assumptionsaremadethatthenodegetsinformationpacketsfromnumeroussourcescontainedbythelimitsofleftoverenergy'Er'aswellasbuffer'Br'correspondingly. The nodes capability tocontrol the packetdrop is 'Pn' packets. Theprocessing of the packets 'n' successfully from exclusive of a drop, the conditions belowshouldassure

1. Completeprocessingofpacketshouldbedonefromthenode
2. A Packet can drop as of a node completely; it means incomplete processing should nothappen,

Hence,tocalculatethe"optimizedabilitytorestrictpacketdrop"metric,considerоptimisticvaluesfor$'n'$as follows

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IV. PERFORMANCE ANALYSIS

PERFORMANCECALCULATIONMETRICS

The execution stage of the particular system is helpful to have an effect on the approval of its users.Moreover, the specified system is appropriate whenever its propositions accept transmission services[14].ThePerformanceinvestigationattributesarecombiningnoticeableandadditionalsystemframework such as the ability to transmit information data at very higher delivery speed and a lesseramount of delay with controllable overhead. Performance analysis attributes measured in this work aredeliveryofthepacket, networklifetime,delayandoverhead.

ENVIRONMENT OF SIMULATION

Network Simulator of version NS 2.34 is used to calculate the performance of the system "energy awarerouting protocol based on the reactive status of mobile nodes". The main purpose of our performanceassessmentistowardsstudytheabilityof"energyawareroutingprotocolbasedontheractivestatusof mobile nodes" to act in response to the various traffic situation in WSN, such as variable packet size,radiotransmissionregion,andmobility.Furthermore,theobjectivewhichplaysakeyroleisthe comparison of the measured results with the evaluated results. Finally, the main objective is to assessthe in-depth performance assessment of "energy aware routing protocol based on the reactive status ofmobilenodes".Simulationparametersareexposedtotable1.

EVALUATIONOFPERFORMANCE

In order to work out the performance of "energy aware routing protocol based on the reactive status ofmobile nodes" on the basis of inconsistent hop count, mobility and radio transmission region. In all therun of the simulation, the input folder was taken, which explains the complete node as well as datapacket information within the system throughout the transmission process. In this work, two simulationscenarios are considered to assess the results in terms of the metrics such as network lifetime, packetdelivery, delay, and the overhead. Variable radio transmission ranges for each node (150m, 200m, and250m) by means of mobility. The variable hops count up among transmission nodes with mobility.

Notations	Description
E	Battery Energy in joules
P_E	Number of packets for node
P_B	Number of packets for buffer
t	Time interval
E_r	Remaining/Residual energy of node
B_r	Remaining/Residual Buffer of node
Pei	Individual energy node packet
Pbi	Individual buffer packet
ORmax	Maximum threshold value
ORmin	Minimum threshold value
B	Buffer of sensor node
P_n	Number of packets

Table1:Notationsusedintheproposedwork

Performanceassessmentofprojectedmethodisapprovedby NS-2throughsuitableexpansioninaccessible libraries and compared by existing algorithms for selection of cluster head with the samenetwork surroundings. Results show that the proposed work outperforms as compare to the availableprotocols. The network performance of the proposed work is good in changing mobility and the diverseradio transmission province. The proposed work isolates the node to turn out to be a blockage node,which gives intern the enhancement of the network lifetime. Furthermore, it minimizes the loss ofinformation packets and improves the packet delivery and reduces the delay. From the results of thesimulation process, it is measured that the

projected work is well suitable for the applications of thewirelesssensornetworks

V. CONCLUSION

The WSNs are progressively more being used in various applications like military, environmental, healthandcommercialetc.Routingisanactivepartandadiversityofroutingprotocolsisdesignedbyconsideringvariousfeaturesandsystemconditions.

Thesenetworksareessentiallydissimilarfromtraditional wired networks and wireless ad-hoc networks. Hence, throughout the simulation results, itconcludes that the proposed routing protocol is well appropriate for various applications of WSNs.Moreover, it enhances the network lifetime as well as accumulates the node energy. Finally, this workgives the performance to examine the existing condition of the node in the network. An attempt hasbeen prepared to recapitulate numerous proposed routing algorithms. Furthermore, the classification ofvarious routing protocols has been done into diverse categories and their parameters also have beendiscussed. The projected mechanism enhances the lifetime of the network with energy efficiency andnetworkperformance.

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