Link Consistency and Energy Efficiency for Improving Throughput in Wireless Sensor Network

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Abstract. Wireless Sensor Networks (WSNs) necessitate lifelong links as well as energy efficiency. Also, the raising commercialization of WSN, supervising applications visit for increased quality of service (QoS). The formation of the energy proficient as well as consistent link is a vital to maintain the enhancement of the WSN performance. In this object, we introduce a Link Consistency and Energy Efficiency (LCEE) for Improving Throughput in Wireless Sensor Network. In this scheme, the link consistency factor (LCF) is used to measure the node link consistency. This LCF is computed by node consistency, Link quality, node remaining energy as well as Link healthiness. The LCEE method primarily enhances the network lifespan durability by minimizing sensor node energy utilization with almost logical throughput as well as the packet obtained rate while the improvement of the QoS parameters in the WSN.

Keywords: Wireless Sensor Network, Link Consistency Factor, Remaining Energy, Node Consistency.

1. Introduction
WSN is a sort of systems made up of thousands of small nodes. The nodes in WSN have restricted processing, storing and conveying capacity. The objective of most WSN is to distinguish functions and it gives careful consideration to the QoS of settlement information packets.

WSN are most attractive developing advancements. WSN can be utilized to perform observing, observation, detecting and estimating tasks. WSN comprises of sensor nodes to detect ecological or physical information. These sensors are little, with constrained preparing and processing assets. These sensors can detect, measure, and accumulate data from the surrounding and transmit that information to the sink. WSN is a developing field in the more extensive zone of remote networking; with appliance varies from observation to social insurance [1].

Link consistency may be pretended with the severe packet conflict, link loss out, as well as node out of communication range. Whilst mostly accessible routing protocols, generally concentrate on energy proficient routing as well as long life. These protocols offer small achievement diluted packet conflict as well as packet forward achievement rates. In common, routing protocols should reflect on the trade-offs among performance enhancement as well as energy proficiency that in the majority cases are inflexible to attain together at a time. The major QoS deprivation is final hop bottle neck in WSN, which
outcomes in short performance and important vitality exhaustion of the nodes; bringing about dishonesty of generally lifetime of the network and inertness [2]. Improvement of Energy-Efficient Technique (IEET) is used to evaluation of network lifetime that attains an energy proficient system. This method is used for energy protection based on the sleep as well as awake scheduling. This protocol minimizes the inactive listening time, thus minimizes the network latency [3].

2. Related Work

Link quality evaluation is a fundamental WSN application since it radically impacts the achievement of transmissions. Prediction of Link Quality turn to machine learning strategies to anticipate the transient advancement of link quality, with the end goal to switch the information transmission on a superior quality link. The Link-Quality Indicator (LQI) is measures the link quality. The projected learning and expectation display introduces an incredible adaptability: it is a common model that can be effectively adjusted to various link quality measurements [4]. Enhancing QoS of WSN technique calculate throughput of the Round Trip Path (RTP) and Round Trip Time (RTT) and contrast the measured throughput and RTT and porch esteems dependent on an examination result will locate a defective sensor inside the system [5].

The purpose of the plan will be on achieve low lifelessness, and to satisfy different QoS in various conditions of a network. The projected calculation abuses numerous nodes' ascribes like separation to the Sink, vitality, history of bare deferral of information to neighbors and likelihood of link accessibility to decide the finest node for conveying distinctive movement provisions. The commitment of the projected calculation is its ability to recognize the information identified with each kind of movement and give different needs to different information classifications so every sort of activity arrangement guarantees to meet the prerequisites of the application provisions [6]. Link Adaptation-based Optimization approach, the life utilization over a link is estimated. The advancement component is subject of particular QoS necessity in term of aggregate end-to-end bit error rate and delay time [7].

Link quality for WSN is anything but difficult to be exasperates by the surrounding. Link quality not just influences the unwavering quality of information transmission in the system, yet in addition decides the execution of related Upper-layer arrange convention. Hence, link quality assessment turns into thinking about inquiry. The connection quality assessment techniques incorporate Link Quality Index (LQI) and information package delivery rate [8]. The effectiveness and unwavering quality of remote system mostly relies on the conveyance intensity of its links. So it is essential to gauge which interface is more dependable and can convey information successfully over an extensive stretch of time. We think about the nature of a links dependent on the accessible estimators fundamentally the Signal to Noise Ratio (SNR), the Received Signal Strength Indicator (RSSI), the Packet Reception Rate (PRR) of the CC2420 radio in an absolutely programming based condition [9].

QoS Analysis intends calculation and recreates the execution frameworks examination of QoS parameters for coordinated robotization of open utility administration, for example, gas, water and power. It is utilized for information combination and information investigation, robbery and spillage recognition [10]. A Link Quality Reliable Routing Protocol (LQRRP) which gives connects unwavering quality and vitality effectiveness for correspondence among nodes is intended. This LQRRP chooses paths on the dependent on the connection quality measurements incorporates packet delivery ratio, quantity of re-transmission count and load. The LQRRP gives connect strength to directing procedure amid the transmission [11].

QoS establish an open investigate concern inside authorised researchers in light of the fact that the fast improvement of microelectronics multiplies innovative appliances for WSNs. These appliances frequently need an association of end-to-end delay and lofty dependability for different contact designs. As the utilization of question driven WSNs winds up adaptable, the requirements to build up QoS bolster turns out to be seriously communicated, especially for medium and lofty traffic loads. In active WSNs, the QoS weakens upon expanded movement stack because of blockage and the mutual medium. Improving QoS in Query-Driven WSN scheme intends a cross layered handover (CLD) calculation with the end goal to enhance disintegrated execution and the QoS by methods for multi-channel excess [12].
Improving Quality of Service approach gives inside and out recreation and investigation of sink portability techniques to beat the final hop bottle neck concern [13].

The QoS measurements in a WSN of different sensor types rely upon the execution of the network convention layers, propelling a far reaching cross-layer configuration way to deal with advance QoS. Advances in vitality reaping strategies empower increments in lifetime of the WSN by drawing out activity of the remote nodes. While the essential target of vitality gathering is to draw out lifetime of the network, it might cause bring down estimations of different QoS measurements amid that life span. The cross-layer constraints that decide QoS esteems in the set up regarding answers for stochastic unique programming circumstances got from multivariate point-process models of transient data streams [14].

An opportunistic routing by responsiveness of energy to accept by dynamic environment. While the sender transmits the information to a multicast group, the sender transmits the information via greater energy between vicinity thus enhance the life span [15]. Modified Russian Peasant Multiplier based on Divide as well as conquer method is utilized for multiplication procedure. Minimizing the chip size, enhancing the quickness as well as minimizing the energy depletion are key critical issues in System strategy [16].

Link channel optimization that needs a channel interface for has the most excellent connection condition, and along these lines, better nature of the signal limitation specified by the least Bit Error Rate (BER). The intended enhancement incorporates control channel task reasonable and least BER requires on characterizing the quantity of transfer of bits. In this scheme, we build up an exploratory portrayal and approve our plan of scientific model with various advances utilized and over an extensive variety of system situation by conveying a real-world ecological checking application with multi-point organize estimation signals that ensure the QOS as vitality utilization, dormancy, packet delivery rate, and throughput [17]. An Efficient Learning Technique to pertains learning strategies to foretell link quality advancement in a WSN and exploit remote connections with the most ideal quality to enhance the packet delivery rate.

End-to-End Data Delivery Reliability prototype intend a system level unwavering quality model, in particular, end-to-end information conveyance dependability (E2E-DDR), for assessing as well as enhancing the dependability execution of WSNs. In this method, an outline is exhibited for catching the planning capacity among the packet gathering proportion, foundation clamour, and received signal strength (RSS). This scheme is used to evaluate the system level dependability as well as advance the WSN arrangement arguments [18].

3. Problem Statement

The majority of the reason for link failure due to degrades the link quality. The link quality degrades owing to link stability, available bandwidth, link life time.

![Figure 1. Link Failure in the route](image)

The figure 1 demonstrates the link failure in the route. In this figure, the path from sender node 7 to receiver node 8 and intermediate nodes are 4, 5 and 6. Here, the link failure occurs between 5 and 6. Thus, the source cannot reach the data to destination. In WSN, the node breakdown happen owing to deficit of resources in several events vital reason is less link quality.
The figure 2 exemplifies the node failure in the route. Here, the node 6 is a sender and 7 is a receiver. The sender node forwards the data to receiver node. But, in this route the 4th node failed due to deplete the energy. As a result, the sender data cannot reach the receiver.

Thus, energy efficiency and highest link quality is a significant factor in the network. To determine this problem, we propose Link Consistency and Energy Efficiency for Improving Packet Delivery in WSN.

4. Proposed Method

In WSN, beginning to present time the major dispute is feasible route for data communication lacking link consistency. In this paper, we concentrate on increasing a link consistency in WSN which fulfills the consistency necessities. Quality of Wireless link is a significant as well as established marker of consistency at every sensor node. The link quality is utilized for WSN coverage as well as node position presume two probable stages of the wireless link such as connected or disconnected.

In WSN, every node updates its node Identity, location, Time to live with link consistency factor (LCF) periodically. This information is stored in the table and the BS maintains all node information and LCF value. The sender checks each node LCF then makes a route path with highest LCF. During route invention procedure the sender forward a join request comprising the receiver ID’s to every the nodes in a WSN. After that, a join-reply is produced by the receiver, added by the nodes in the path and are sent out back to the sender along with their position.

4.1 Link Consistency Factor

The Link Consistency Factor is calculated by four individual components regarding the link consistency of the node specified in the formula.

\[
LCF = \begin{bmatrix} NC & LQ \\ LH & NRE \end{bmatrix}
\]  

Where

NC \rightarrow Node Consistency

LQ \rightarrow Link Quality

NRE \rightarrow Node Remaining Energy

LH \rightarrow Link Healthiness
4.2 Node Consistency (NC)

Node Consistency denotes the node character. The character is determined on the feedback of adjacent nodes. If the node is reliable, unselfishness, then an encouraging feedback is received otherwise get discouraging feedback. The node consistency determines whether the node is a consistency or inconsistency node. It is measured by the equation 2.

\[ NC = \frac{\lambda}{\lambda + \gamma} \]  

where

\[ \lambda = \text{encouraging feedback of adjacent node} \]
\[ \gamma = \text{discouraging feedback of adjacent node} \]

The node Consistency value rests between 0 and 1. If the node Consistency is higher than or identical to 0.5, next the node is believed to be the consistency node Otherwise it is an inconsistency.

4.3 Link Quality

The link quality (LQ) among two nodes is inversely proportional to the Bit Error Rate (BER). Here \( \alpha \) is a constant time. The BER is measured by wireless channel interference and communication range. The link Quality computation is given below.

\[ LQ = \alpha - \frac{1}{BER} \]  

Residual Energy

RE is the remaining energy (RE) in a node at a present time and is a vital factor for choosing a node as a relay node. The remaining energy is computed by the equation 4.

\[ \text{Remaining Energy} = \text{Preliminary Energy} - \text{present Energy} \]  

4.4 Link Healthiness

The Link Healthiness (LH) inversely proportional to the rates at that route request (RREQ) is transmitting via the nodes and route reply (RREP) is yield as an acceptance for the representing RREQ. It is evaluated by the Equation 5.

\[ LH = \frac{1}{(\text{Transmit}_{\text{req}} \times \text{Accept}_{\text{req}})} \]  

4.5 Link Consistency based Validation

The link Consistency Factor validation is executed to evaluate the next relay election as component of the route finding itself and the majority link consistency nodes are validated and separated for the current hop to choose the next relay.

In order to confirm the expected values, we evaluate the next value both on the previous LCF value, current LCF value and then predict the expected LCF values. This value is denoted as a next value as indicated in figure the expected value is modified the table.
This value is utilized for discovering the next transmitting nodes from sensor to BS. Suppose, transmitting nodes LCF value is less than the threshold value during sensor node takes another route to transmit the data.

5. Performance Evaluation
To execute simulation examination, we utilized the NS-2.35 that incorporates the 802.15.4 MAC protocol. This protocol is functioning on the 2.4 GHz physical layer and each sensor node transaction range is preset to 150 metre. The simulation of the proposed scheme has 30 nodes are deployed in the simulation area 500×500. In this simulation topology, the BS node plays an Owner of complete network as well as every sensor node function is sensing, data forwarding as well as obtaining the data. The packet traffic is yielded with constant bit rate (CBR). This simulation examination, we measured the following metrics namely Packet Obtained Rate, Latency, Loss Packet Rate, Average Remaining Energy, Throughput.

5.1. Packet Obtained Rate (POR)
It is defined as the ratio among the amount of data packets perfectly obtained by the BS and the amount of data packets yielded by the sensor nodes. This metric mutually constitutes the link reliability of the data gathering procedure.

\[
POR = \frac{\sum_{i}^{n} \text{Packets Obtained}}{\text{Time}}
\]  

Figure 3. LCF Validation of expected value
The POR of IEET and LCEE are diagrammed in Figure 4.6. It illustrates the POR of LCEE is better than the IEET for simulation time 100 seconds. There is an exciting enhance in obtaining the packet in LCEE. The LCEE method selects the relay node by link consistency factor. Thus, enhances the network POR in the system.

5.2. Packet Drop Rate (PDR)

PDR is denoted as the distinction among the forward packets and obtained packets in the communication MANET per particular time. PDR is measured by Equation 7.

\[
PDR = \frac{\sum_{0}^{n} \text{Forward Packets} - \text{Obtained Packets}}{\text{Time}}
\]  

(7)

From figure 5 illustrate the PDR of LCEE as well as IEET. The LCEE method selects the relay node by link quality, link healthiness, and node consistency. The LCEE has smaller PDR in account of the improved function of the WSN.
5.3. Latency
It is defined as the time period from while the data packet communication is initiated at the source to while the data packet is perfectly obtained by the sink.

\[
\text{Latency} = \frac{\sum_{0}^{n}(\text{Packet Obtained Time} - \text{Packet Forward Time})}{n}
\]  

\( (8) \)

Figure 6. Latency of IEET and LCEE

The figure, 6 illustrates the latency of IEET as well as LCEE. It illustrates the latency of LCEE is lesser compared to the IEET. In LCEE, each sensor checked via node consistency factor thus chooses the relay node is a consistent. So, transmit the data to the destination with in a time period. Therefore, time delay is diminished when compared to the PPMA method. The diminution of latency is enhancing the WSN performance.

5.4. Throughput
It is the vital parameter for measuring the operations of network. In this protocol, the throughput is specified as the amount of data packets effectively obtained at the BS.

\[
\text{Throughput} = \frac{\sum_{0}^{n}\text{Packets Received}(n) \times \text{Packet size}}{\text{Time}}
\]  

\( (9) \)
5.5. Residual Energy

It is defined as the whole energy exhausted by every sensor node divided by the amount of data packets perfectly distributed to the BS. This metric evaluates the energy efficiency of the WSN.

5.6. Consistency Ratio

The consistency rate graph illustrates the average consistency values received for several nodes at the simulation time 100 second. This consistency ratio assists for selecting the best forwarder node.
Figure 9 illustrates the Consistency Ratio of IEET and LCEE. It describes the LCEE scheme nodes have the highest consistency ratio. As a result, this node diminishes the packet losses in the network. But IEET scheme nodes have less consistency ratio.

6. Conclusion
In this protocol, we introduced a Link Consistency and Energy Efficiency for Improving Throughput in WSN. Here, the link consistency factor is used to measure the node link consistency. This LCF is computed by node consistency, Link quality, node remaining energy as well as Link healthiness. The introduced protocol fulfills the link consistency as well as additional energy saving than IEET based on our simulation results, correspondingly. Usually, this protocol provides the consistency of link as well as appreciably enhanced network performance. Simulation analysis proves that the LCEE enhanced the throughput as well as minimized the network latency in the network.

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