

# Energy Efficient Link-Delay Aware Routing Using Predicted Remaining Deliveries in Wireless Sensor Networks

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**ABSTRACT:** This paper investigates the matter of energy consumption in wireless detector networks. Wireless detector nodes deployed in harsh atmosphere wherever the conditions modification drastically suffer from sharp changes in link quality and node standing. The end-to-end delay of every detector node varies because of the variation of link quality and node standing. On the opposite hand, the detector nodes area unit equipped restricted energy and it's a good concern to increase the network lifespan. To address those issues, this paper proposes a unique and easy routing metric, foreseen remaining deliveries (PRD), combining parameters, as well as the residual energy, link quality, end-to-end delay, and distance along to realize higher network performance. PRD assigns weights to individual links also as end-to-end delay, therefore on mirror the node standing within the long-term of the network. Large-scale simulation results demonstrate that PRD performs higher than the wide used ETX metric also as different 2 metrics devised recently in terms of energy consumption and end-to-end delay, whereas guaranteeing packet delivery quantitative relation.

**KEYWORDS:** Sensor Networks, Routing, Predicted Remaining Deliveries, KNN

## I. INTRODUCTION

Wireless sensor networks have attracted great attention due to their various potential applications in the area of forest fire detection, transportation, and industrial automation, etc. Generally, sensor nodes are deployed in a specific region and cannot move after deployed. The main task of the sensor nodes is to periodically sense the environment and transmit the information to the data center known as the sink. Sensor nodes are usually battery-powered, and it is difficult to replace or recharge the battery. Due to the limited energy, sensor nodes drain their energy quickly, leading to the sensing area uncovered.

Therefore, energy conservation becomes a critical concern in WSNs. In recent years, many energy-efficient techniques for wireless sensor networks have been developed to extend the network lifetime, including duty-cycle scheduling, medium access control techniques and compressive sensing.

In a heterogeneous device actor network, packet loss might occur thanks to unhealthy link quality, overflow of buffer, and low energy levels. Retransmission of the lost packets ends up in additional energy consumption and delay. guaranteeing knowledge reliableness and minimum delay demand whereas rising energy potency are difficult problems in an exceedingly resource-constrained heterogeneous device actor network. during this paper, a fuzzy-based delay and energy-aware intelligent routing mechanism has been planned to pick economical routes. Within the planned mechanism, routing selections are taken employing a formal logic system by considering network resources, like residual energy, quality of link, obtainable buffer size, and distance (proximity). in an exceedingly network, a node with higher residual energy, higher free obtainable buffer, smart link quality, and shut distance (proximity) gets chance to become a next hop node in an exceedingly routing path. moreover, network performance has been analyzed with numerous network states. Simulation has been disbursed exploitation Network machine three by considering

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performance metrics, like delay, variety of retransmissions, energy consumption, lifetime, and network stability of the network

Wireless sensing element network (WSN) consists of an oversized variety of sensing element nodes densely deployed in inhospitable physical environments. because of limitations of sensing element nodes in terms of memory, energy and process capacities, the foremost necessary issue for coming up with sensing element network protocols is energy potency. though energy potency may be a major concern in WSNs, it typically suffers from the addition network delay. during this work, we tend to 1st propose associate degree energy and delay economical hierarchic agglomeration theme known as BHC (Bruijn hierarchic Clustering) for WSNs. It permits knowledge transmission from sensing element nodes to the bottom station (BS) within the style of multi-hop, multi-path and guarantee energy potency and cheap delay. Next, we offer knowledge distribution algorithms from the sensing element nodes to BS as quickly as attainable and therefore the most energy economical. to judge the appropriateness of our proposal, we tend to analyze the simulation results against another protocol in terms of communication overhead, total quantity of energy dissipated in system and network delay victimization ns-2 network machine.

Because detector node usually powered and in most cases it's going to not be doable to vary or recharge batteries, the key challenge in wireless detector network (WSNs) style is that the energy-efficiency and the way to touch upon the trade-off between it and therefore the QoS parameters needed by some applications. This paper studies the QoS of associate degree energy-efficiency cluster-based routing protocol known as Energy-Aware routing Protocol (EAP) in terms of time period, delay, loss proportion, and output, and proposes some modifications thereon to boost its performance. The changed protocol offers higher characteristics in terms of packet loss, delay, and output, however slightly affects time period negatively. Simulation results showed that the changed protocol considerably outperforms EAP in terms of packet loss proportion by on the average 93.4%.

Self organizing, wireless sensors networks are associate emerging and difficult technology that's attracting massive attention within the sensing and watching community. Several routing protocols are projected among these protocols, the adjustive routing protocols are terribly engaging as a result of they need low routing overhead. As a result, the routes tend to own the shortest hop count and contain weak links that typically give low performance and are prone to breaks. during this paper we tend to introduce associate adjustive routing protocol referred to as energy aware routing that's supposed to supply a reliable transmission surroundings with low energy consumption. This protocol with efficiency utilizes the energy handiness and also the received signal strength of the nodes to spot the simplest potential route to the destination. Simulation results show that the energy aware routing theme achieves a lot of higher performance than the classical routing protocols, even within the presence of high node density and overcomes coincidental packet forwarding.

## II. RELATED WORK

Basically, ETX captures the link quality of a routing path and helps to choose a path with the best link quality, whereas ETT captures the end-to-end delay of a routing path and serves to select a path with the shortest end-to-end delay. Nevertheless, neither ETX nor ETT take the residual energy of each sensor node into account, leading to the quick death of sensor nodes with low energy level. To strike a balance between energy efficiency and delay, it is necessary to combine both link quality and end-to-end delay together for routing metric design.

## III. PREDICTED REMAINING DELIVERIES

This paper focuses on the routing metric design for the applications of WSNs where the environment changes drastically, e.g. the intertidal environment. Our experiments of a WSN system deployed in the intertidal environment exhibit long end-to-end delay and unbalanced energy consumption among sensor nodes, which will be described in detail in the next section. Yet, designing such a routing metric poses several challenges. The first challenge is how to overcome the environment variations and reflect the status of the sensor nodes. In the harsh environment such as the intertidal area, the status of sensor nodes deployed for monitoring temperature and sea creatures are impacted by the

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tide, sea waves and the sea wind. Sensor nodes may change between above water and under water due to the change of the tidal level, bringing about variations in link quality and end-to-end delay.

## **AWARE ROUTING**

We consider a network of static energy controlled sensors that are deployed over a flat region with each node knowing its own location. All nodes are assigned with a unique ID and all nodes are participating in the network forward the given data. Additionally, these sensor nodes have limited power, storage and energy, while the sink nodes have powerful resources to perform any tasks or communicate with the sensor nodes. To allow an increase in the network lifetime mechanisms are done in routing protocols to verify other parameters beyond the hop count that accept a more intelligent route establishment. The energy efficient routing algorithm proposed is used for making a decision on which neighbour a sensor node should forward the data message. A node is chosen to forward the data based on its residual energy level and signal strength.

## **Active Routing Protocol**

We have tested our decomposition procedure on 64 network configurations wherever the routing AND gate allocations are computed for the virtual methods within the network. every of the networks consists of 20 nodes. Initial routing calculations yield between 300 and 400 virtual methods. we tend to use a threshold price of 30 circuits. With this threshold price, the numbers of skinny virtual methods consist the vary of 150. when applying the decomposition procedure, the varieties of unrecompensed skinny virtual methods consist the vary of zero to 16; the typical number is regarding half dozen.5. The varieties of latest primary virtual methods fashioned consist the vary of ten to 31; the typical number of latest primary virtual methods fashioned is regarding nineteen. this implies that for these originally skinny virtual methods, no intermediate switch of their end-to-end traffic is needed due to success in traffic aggregation from longer skinny virtual methods that use these virtual methods in concert of their 2 logical hops. The verities of latest virtual-path links fashioned consist the vary of zero to 9; the typical number is regarding three (recall that virtual-path links carry solely transit traffic).

## **IV. EXPERIMENTAL RESULTS**

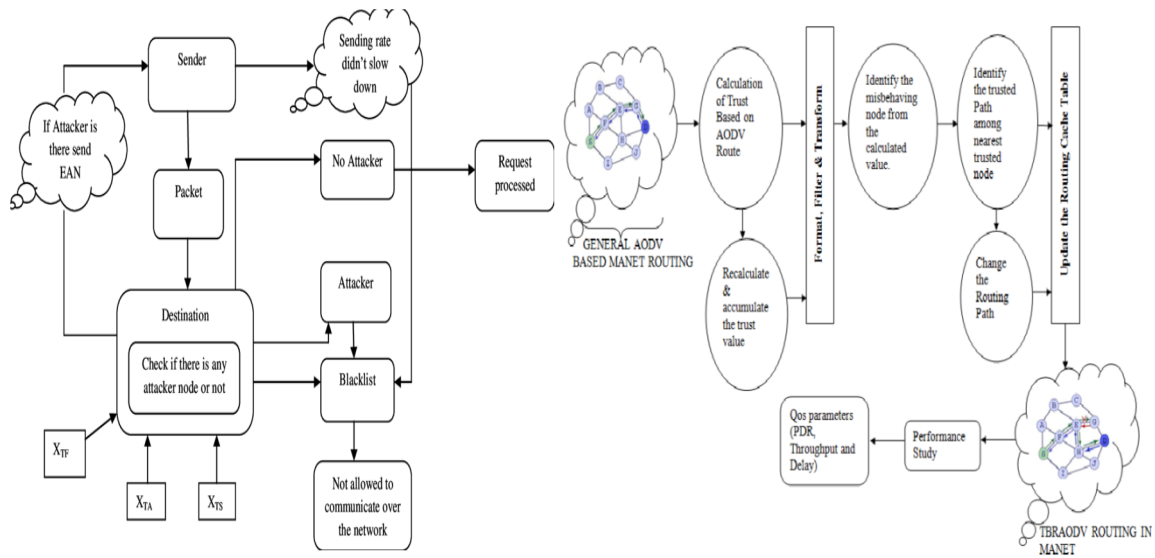
A quality output is one that meets the requirements of the top user and presents the data clearly. In any system results of process square measure communicated to the users and to alternative system through outputs. In output style it's determined however the data is to be displaced for immediate want and conjointly the textual matter output. It is the foremost necessary and direct supply data to the user. Efficient and intelligent output style improves the system's relationship to assist user decision-making,

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Designing computer output should proceed in an organized well thought out manner, the correct output should be developed whereas making certain that every output part is meant in order that individuals can realize the system will use simply and effectively. once analysis style pc output, they must determine the particular output that's required to fulfill the necessities.

## 1. Select ways for presenting data.

Create document, report, or different formats that contain data made by the system. The output type of associate data system ought to accomplish one or a lot of the subsequent objectives. Convey data regarding past activities, current standing or projections of the Future.

- ❖ Signal necessary events, opportunities, problems, or warnings.
- ❖ Trigger associate action.
- ❖ Confirm associate action.

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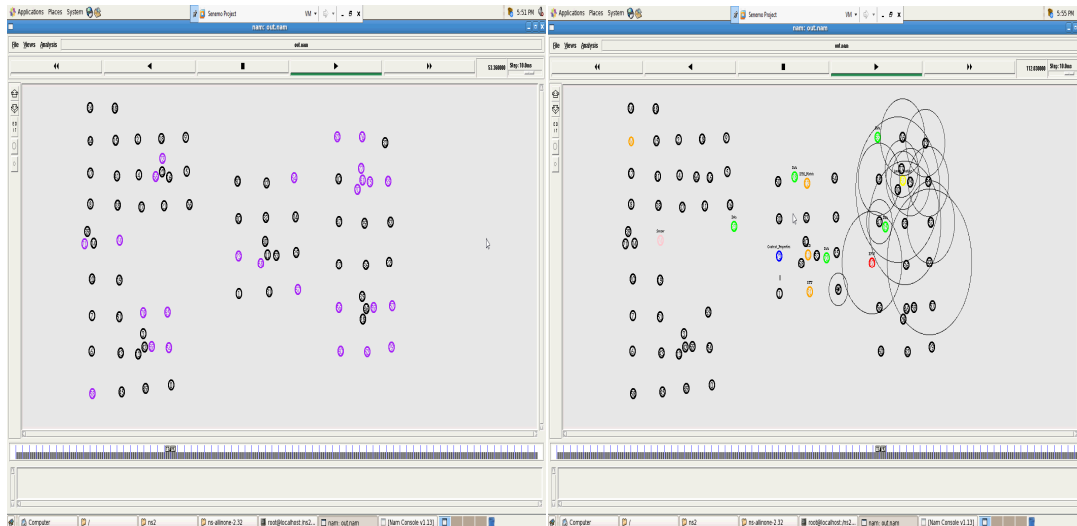


Figure 1

Figure 2

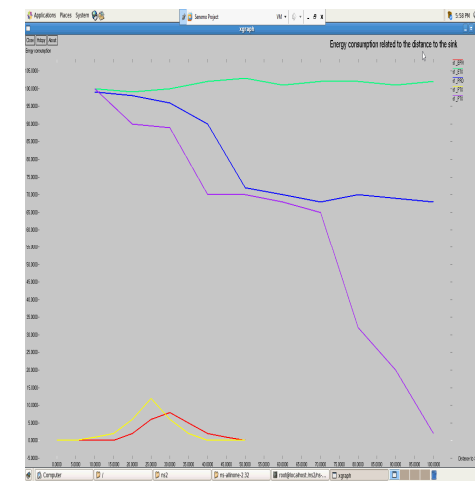


Figure 3

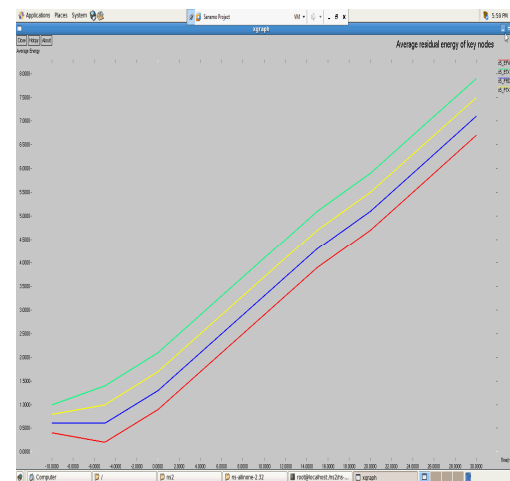


Figure 4

Figure1:Node Linking, Figure2:Data Transmission, Figure3:Energy Consumption to the sink, Figure4: Average Residual Energy

As presented in Theorem 2, the average energy consumption of sensor nodes with an average distance  $d$  to the sink increases drastically with the decrease of  $d$ . As shown in Fig. 3, the average energy consumption of sensor nodes located in different distances to the sink are plotted using both the simulation results and the theoretical results. The energy consumption in simulations with PRD, EFW, PTX and ETX all show a drastic increase trend with the decrease of the distance to the sink. The simulation results fit well with the theoretical one, indicating that the theoretical analysis in Theorem 2 exactly reflects the nature of the WSNs. Moreover, Fig. 3 also illustrates that the average energy consumption of all the four metrics increase in a zigzag way with the decrease of the distance, while the energy consumption related to each range of distance to the sink with PRD is a bit smaller than those with ETX, EFW and PTX. The zigzag performance is due to the fact that some sensor nodes are more likely to be chosen as parent nodes to forward data. Note that in the theoretical analysis we assume that an optimum routing protocol is applied and the

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throughput of sensor nodes in similar distance to the sink is almost the same, whereas in fact those assumptions can hardly be satisfied in real WSNs.

Fig. 8 displays the average residual energy of the key sensor nodes located in the vicinity of the sink. The key sensor nodes are responsible for forwarding a large amount of data. If the key sensor nodes exhaust all their energy, the network is no longer connected and loses the ability to collect information from the environment. The average residual energy of key nodes in PRD decreases much slower than those in ETX, EFW and PTX. Therefore the key sensor nodes in PRD achieve a much longer sensor lifetime, contributing to a much longer network lifetime.

## V. CONCLUSION

This paper proposes a novel link-delay aware energy efficient routing metric called PRD for the routing path selection tailored for WSNs deployed in harsh environments, where the networks are exposed to extremely long end-to-end delay and unbalanced energy consumption among sensor nodes. PRD captures the predicted remaining deliveries within one unit of delay, which reflects the ability of each sensor node to forward packets. PRD also takes the end-to-end delay into consideration. The main purposes of PRD are to balance the energy consumption of the sensor nodes and extend the network lifetime, as well as controlling the end-to-end delay. Large-scale simulations are conducted to evaluate the performance of PRD. The results indicate that PRD outperforms traditional metrics such as ETX, EFW and PTX in terms of end-to-end delay, energy consumption and network lifetime performance, while guaranteeing high packet delivery ratio. Therefore we can conclude that the proposed PRD metric can be an effective and efficient solution to choose appropriate routing paths for WSNs deployed in harsh environments.

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