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EEQRP-Energy Efficient Quality Routing Protocol for Wireless Sensor Networks

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Abstract

Emerging technology of research is increasing requirement for a real-time application in Wireless Sensor Networks (WSNs) has made the quality based communication protocols an interesting and hot research topic. Satisfying quality requirements for the different quality based applications of WSNs raises significant challenges. More precisely, the networking protocols need to cope up with energy constraints, while providing precise quality guarantee. Therefore, enabling quality applications in sensor networks requires energy and quality awareness in different layers of the protocol stack. In many of these applications, the network traffic is mixed of delay sensitive and delay tolerant traffic. Hence, Quality of Service (QoS) routing becomes an important issue. The main objective of this idea is to develop the path for quality of network and to further improve throughput, routing overhead and bandwidth and at the same time to create energy enhanced way with excellent QoS. In this research paper, the propose model an Energy Efficient Quality Routing Protocol (EEQRP) technique based on energy efficient protocol that can be used to design fast, tiny, more energetic and efficient way then existing routing protocols, they evaluate and compare the performance of our routing protocol (EEQRP). Network Simulator (NS2) is used to carry out and test the proposed system achieves lower average delay, more energy savings, and higher packet delivery ratio than the existing protocol.

Keywords: *WSN, network quality, EEQRP, PDR, delay, energy*

INTRODUCTION

In the recent years, these sensor devices are equipped with a small battery, a tiny microprocessor, a radio transceiver, and a set of transducers that used to acquire information that reflect the changes in the surrounding environment of the sensor node. The emergence of these low cost and small size wireless sensor devices has motivated intensive research in the last decade addressing the potential of collaboration among sensors in data gathering and processing, which led to the invention of Wireless Sensor Networks (WSNs) [1, 2]. A typical WSN consists of a number of sensor devices that collaborate with each other to accomplish a common task. The areas of applications of WSNs vary from civil, healthcare, and environmental to military. However, with the specific consideration of the unique properties of sensor networks such limited power, stringent bandwidth, dynamic topology, high network density and large scale deployments have posed many challenges in the design and management of sensor networks. These challenges have demanded energy awareness and robust protocol designs at all layers of the networking protocol stack [3–6]. Efficient utilization of sensor's energy resources and maximizing the network lifetime were and still are the main design considerations for the most proposed protocols and algorithms for sensor networks and have dominated most of the research in WSNs. However, depending on the type of application, the generated sensory data normally have different attributes, where it may contain delay sensitive and delay tolerant data. Furthermore, the introduction of multimedia sensor networks along with the increasing interest in real-time applications have made strict constraints on both delay and throughput in order to report the time-critical data to the processing centre or sink within certain time limits and bandwidth requirements without any loss [7, 8].

The QoS based protocols allow sensor nodes to make a trade-off between the energy consumption and some QoS metrics before delivering the data to the sink node. Finally, multi-path routing protocols use multiple paths rather than a single path in order to improve the network performance in terms of reliability and robustness. Multi-path routing establishes multiple paths between the source and destination pair. Multi-path routing protocols have been discussed in the literature for several years now. Multi-path routing has focused on the use of multiple paths primarily for load balancing, fault tolerance, bandwidth aggregation, and reduced delay. We focus on supporting quality of service through multi-path routing. In this paper, we propose EEQRP protocol for WSNs to recover from node failures and achieve load balancing through splitting up the traffic across a set of available node-disjoint paths in order to efficiently balance the energy consumption over multiple sensor nodes. Furthermore, EEQRP increases the reliability of data delivery through utilizing a light weight XOR-based forward error correction technique to provide data redundancy. Data redundancy increases resiliency to path failures and enables the protocol to recover lost data and reconstruct the original message, while avoiding any excessive delay due to data retransmissions. EEQRP uses the residual energy, node available buffer size, and signal-to-noise ratio to predict the next hop through the path construction phase.

BACKGROUND

Diversity coding for transparent self-healing and fault-tolerant communication networks was done by Ayanoglu, *et al.* (1993). Energy-efficient multipath routing in wireless sensor networks was done by Deepak Ganesan, *et al.* (2001). Multipath routing in ad hoc wireless networks with directional antenna was done by Somprakash Bandyopadhyay, *et al*. (2002). Directed diffusion for wireless sensor networking was done by Ramesh Govindan, *et al.* (2002). A wireless sensor network for habitat monitoring was done by Mainwaring, *et al.* (2002). An energy aware QoS routing protocol for wireless sensor networks was analyzed by Akkaya, Younis (2003). Trade-off between traffic overhead and reliability in multipath routing for wireless sensor networks was done by Dulman, *et al.* (2003). A stateless protocol for real-time communication in sensor networks was done by He, *et al.* (2003). Routing techniques in wireless sensor networks was done by Jamal Al-Karaki, Ahmed Kamal (2004). QoS support in wireless sensor networks: a survey was done by Chen, Varshney (2004) [9]. Performance optimization using multipath routing in mobile ad hoc and wireless sensor networks was done by Wenjing Lou, *et al*. (2005). A survey on routing protocols for wireless sensor networks was done by Kemal Akkaya and Mohamed Younis (2005). A wireless sensor network for battlefield surveillance was done by Bokareva, *et al*. (2006). MMSPEED: multipath multispeed protocol for QoS guarantee of reliability and timelines in wireless sensor networks was done by Felemban, *et al*. (2006). A wireless sensor network for early detection of forest fires was done by Hefeeda and Bagheri (2007). An energy efficient multipath routing protocol for wireless sensor networks was done by Ye Ming Lu and Wong (2007). Trade-Off between

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PROPOSED METHOD

In this section, description of EEQRP protocol define some assumptions, then they provide the details of multiple paths discovery and maintenance, as well as the traffic allocation and data transmission across the multiple paths steps given below.

Step 1: *HELLO message structure Assumptions*

Source ID	Hop Count	Residual Energy	Free Buffer	Link Quality

Step 2: *Link cost function*

$$\text{Next hop} = \max_{y \in Nx}\{\alpha E_{resd,y} + \beta B_{buffer,y} + \gamma I_{interference,xy}\},$$

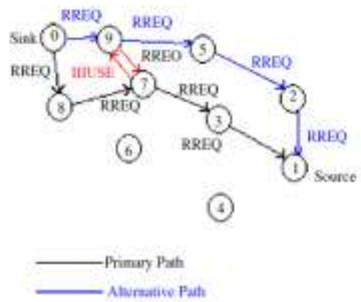
.

$$C_{total,P} = \sum_{i=1}^{K-1} l_{(xy)_i}.$$

Step 3: *Paths discovery phase / RREQ message structure*

Source ID	Dest. ID	Route ID	Residual Energy	Free Buffer	Link Quality	Route Cost

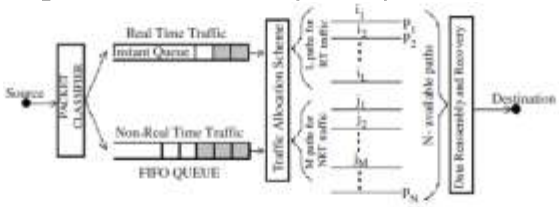
Fig. 3. RREQ message structure.



Step 4: *Paths selection*

$$k = x_{\alpha} \cdot \sqrt{\sum_{i=1}^{N} p_i(1-p_i) + \sum_{i=1}^{N} p_i}$$

Step 5: *Functional diagram of the EEQRP*



SIMULATION PARAMETERS

Table 1: *Simulation Parameter.*

Parameter	Values
Simulation area	680m*680m
Number of sensors	300
Average speed of nodes	0–25 meter/second
Number of packets sender	40
Constant bit rate	2 (packets/second)
Packet size	512 bytes
Node beacon interval	0.5 (seconds)
MAC protocol	802.11 DCF
Initial energy/node	100 joules
Simulation time	1000 sec

RESULTS AND DISCUSSION

They evaluate the performance and authenticate the effectiveness of our EEQRP through NS2 implement and conduct a set of simulation experiments for our protocol [12–15]. Our simulation environment consists of 350 sensor nodes selected randomly in a area of 680m*680m with transmission range set to 25 m all nodes are identical. Table 1 shows the simulation parameters. The parameter metrics used in the evaluation are the remaining energy, throughput and average delay. Simulation results are averaged over several simulation runs

Table 2: *Results of Parameter Values.*

Protocol / Packet arrival rate	20	40	60	80	100
Packet Delivery Ratio					
EEQRP	0.88	0.84	0.80	0.76	0.72
Existing	0.82	0.77	0.69	0.64	0.59
Average Delay					
EEQRP	0.36	0.32	0.28	0.24	0.20
Existing	0.41	0.38	0.35	0.32	0.29
Remaining Energy					
EEQRP	0.74	0.71	0.68	0.65	0.62
Existing	0.63	0.60	0.57	0.54	0.51

Table 2 and Figure 1 shows the graph of the PDR when the topology size is increased 1m to 680m, the number of sensors 300.

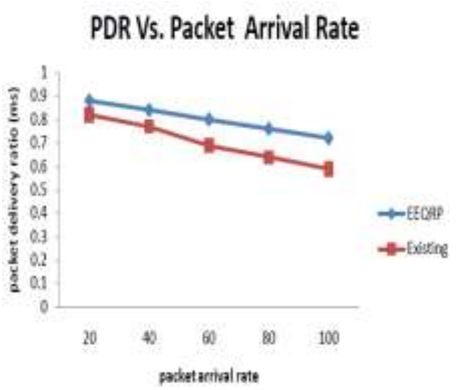


Fig. 1: *PDR vs. Packet Arrival Rate.*

It is clear from the simulation results that the EEQRP has the highest delivery ratio in comparison with existing, when there are 1 to 300 sensors. When the number of sensors increases, the connectivity among the nodes also increases; this enables the proposed method to identify efficient paths which in turn increase the delivery ratio.

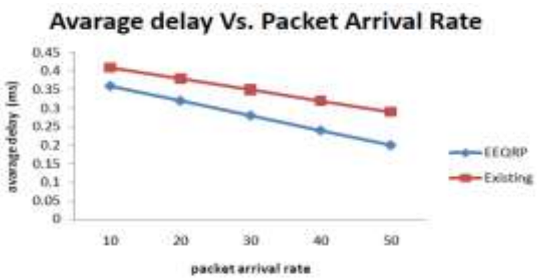


Fig. 2: *Average Delay vs. Packet Arrival Rate.*

It is observed from Figure 2 and Table 2 that when compared with exiting protocol, EEQRP decreases the delay by 7% with the increase in the number of sensors from 1 to 300 [16]. The proposed algorithm EEQRP finds the primary and secondary highest forward capacity route in between the sender and receiver [17–20].

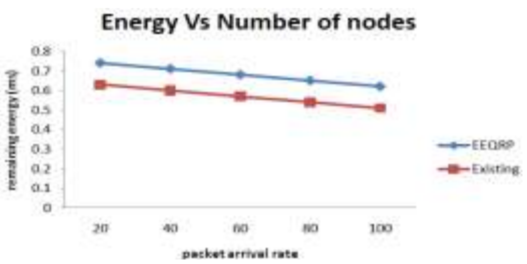


Fig. 3: *Remaining Energy vs. Packet Arrival Rate.*

The impact of the number of nodes on the remaining energy is analysed using the two protocols and the simulation results are shown in, Figure 3 and Table 2 describe the increase in the remaining energy obtained by the proposed EEQRP when there are 1 to 300 sensors. EEQRP protocol reduces the energy by 11% as the proposed algorithm is capable of finding the minimum link failed unbreakable short route between the source and destination.

CONCLUSION

In the recent research years there has been a lot of interest within the field energy aware quality protocol in MANET, they have offered our EEQRP protocol; an energy efficient and quality aware routing protocol designed for WSNs to provide service differentiation by giving real-time traffic absolute preferential treatment over the non-real-time traffic. Our EEQRP protocol uses the residual energy, node available buffer size, and signal-to-noise ratio to predict the next hop through the paths construction phase. EEQRP splits up the transmitted message into a number of segments of equal size, adds correction codes, and then transmits it over multiple paths simultaneously to increase the probability that an essential portion of the packet is received at the destination without incurring excessive delay. Simulation results have shown that our protocol (EEQRP) provides better performance compared to the existing protocol and also improves more remaining energy to more than 11% compared to the existing protocol, improves delivery ratio 8% to more compared to the existing routing protocol, and minimize average delay below 7% compared to the existing Protocol. Finally EEQRP not only reduces delay but also reduces routing overhead.

Our future work, apply proposed protocol (EEQRP) to analysis various environments reduce maximum energy, apply different secure algorithm to provide effective secure communication, testing the performance of EEQRP in real network environment instead of software simulation.

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