A Survey of Quality of Service based Routing Algorithms for Wireless Sensor Networks

Prof. Dr. Sachin B. Takale[1], Prof. Dr. Sarika S. Patil[2]
[1]*Associate Professor, ECE Dept., SOES, MIT Art, Design and Technology University, Pune*
[2]*Assistant Professor, E & TC Dept., Sinhgad College of Engineering, Pune*

***Abstract*— Wireless sensor networks have been a key element of technological, industrial and societal growth over the last four decades. However, the design and deployment of wireless sensor network is challenging in situations wherein intra-network communication needs a network-wide, application-specific quality of service guarantee. An expectation of this kind is hard to meet in a network having resource-constrained elements. The constraints on the resources are due to cost, size and application area. Use of appropriate routing algorithm can save the resources while availing required quality of service guarantees. In this paper, survey of such protocols is presented. The quality of service parameters used by these protocols and their percentage is presented at the end of paper. This paper is helpful for developers of quality of service based routing algorithms for wireless sensor networks.**

***Index Terms*— Wireless Sensor Networks, Quality of Service, Routing in wireless sensor networks**

I. INTRODUCTION

Wireless sensor network (WSN) is comprised of sensor nodes with capabilities to sense, process and transmit the sensed data to designated node, called as sink node. Such a network is deployed for monitoring the physical parameters such as temperature, humidity, water level etc. Such a system with ability to communicate the sensed data over the wireless link greatly helps the physical parameter monitoring and controlling systems [1].

With the increase in application domains of WSN, the need for quality of service (QoS) provision became more prominent. QoS is a set of service requirements to be met by the network during the packet flow from source to destination [2]. Generally, applications or users mention the QoS requirement, and the network should provide it. Delay, jitter, throughput and packet delivery ratio are the common QoS parameters in WSN.

II. ROUTING ALGORITHMS IN WSN

Routing is the process to determine the best possible path from source to destination in the communication network. Routing algorithms assist the sensor nodes during collaboration with other sensor nodes, data collection, processing and sending the data to the sink node in an efficient manner. Several issues must be taken into account while designing routing protocol in WSN. First, for enhancing the network lifetime, the mechanisms used for route exploration and data transmission should be energy efficient. Second issue is related to the nodes in network which operate without manual intervention. The network is expected to exhibit autonomic properties, meaning that the protocol being used should be self-organizing and able to handle failures of individuals. Last point to consider is that, the routing protocol must be able to handle large number of nodes which are scattered in networks. Routing techniques in WSN are divided on the basis of network structure and protocol operation. The later category protocols are further classified into multipath-based, query-based, negotiation-based, QoS-based, and coherent-based. This classification considers the operation of routing protocol [3].

III. QOS BASED ROUTING ALGORITHMS

A QoS aware routing algorithm for multi-hop WSNs should balance energy efficiency and adaptability while keeping low routing overhead. The proposed work is about the development of QoS based routing algorithm, so QoS aware protocols developed for WSNs are studied and evaluated [4]. Sequential Assignment Routing (SAR) proposed in is first routing protocol in the series of QoS based routing algorithms. SAR introduces the notion of QoS assurance in routing algorithms [5] . The routing path in SAR is selected on three factors which are QoS offered by each path, the priority level of each packet and energy resource availability. The multi-path approach is used to avoid an issue like path failure and localized path restoration

schemes are used. Although, SAR deals with fault occurrences and easy recovery from the same. But SAR suffers from the overhead of maintaining the routing tables and states of each sensor node. This situation becomes worse when a large number of nodes exist in the network.

In the SPEED routing algorithm [6] , each sensor node collects and maintain information of its neighbours and their geographic location is used to find the paths. As the name of the algorithm suggests, SPEED assure that each packet in the network will be delivered to the destination at a certain speed. Due to this feature, it becomes easy for each application to estimate the end-to-end delay for the transmitted packets. Delay can be determined using source to base station distance and speed of the packet. SPEED involve maintaining information about its neighbours. But SPEED is less energy-efficient and lacks a packet prioritization scheme.

Akkaya and Younis proposed Energy and QoS aware routing (EAQAR) protocol in WSN [7] . It is a table-driven protocol that maintains multiple paths from source to destination. These paths are having cost which is calculated on the basis of energy, the distance between nodes and error rates. Traffic classification and traffic based treatment is also considered. Path determination is performed in a centralized manner which requires knowledge of complete topology at the base station.

D.P. Agrawal et al. proposed QoS and energy-aware routing for real-time traffic in wireless sensor networks [8] . In this protocol, priority is assigned to each neighbour. Also, different queues are maintained for real-time and non-real-time data. But this protocol does not consider data aggregation and suffers from congestion.

E. Felemban et. al. proposed a protocol named MMSPEED, a multispeed, multipath protocol for QoS guarantee [9]. The QoS in this protocol is measured on the basis of reliability and timeliness in wireless sensor networks. This protocol aims to provide QoS support that allows packets to select the best possible combination of service parameters depending on their requirements in terms of timeliness and reliability. However, MMSPEED fails to consider energy issues; hence it remains applicable to short-duration WSN applications.

Ze Li, Haiying Shen developed QoS-Oriented Distributed (QOD) Routing Protocol for Hybrid Wireless Networks [10]. Hybrid networks are networks in which different kinds of nodes are connected. Every node in such a network can play a dual role of the transmitter as well as the receiver. QOD employs three major algorithms while assuring the quality of service. This algorithm includes QOS guaranteed neighbour selection, distributed packet scheduling algorithm and mobility-based segment resizing algorithm. These algorithms ensure efficient, timely delivery of packets by taking advantage of neighbours' properties. The performance of QOD is compared with E-AODV which is an enhanced version of AODV. Mobility, workload and network size are the three parameters that are used to compare these two protocols. However, the protocol has to maintain different fields of information related to adjacent nodes.

Ghassan Samara, Mohammad Aljaidi propose an energy-ware, quality of service-aware routing (EEQSR) protocol for wireless sensor networks that can run competently with best-effort traffic processing. The protocol is designed to maximize the network lifetime of the network by balancing the energy consumption across multiple nodes. It is achieved using the service differentiation concept and shortest path calculation using the nearest neighbour algorithm. However, EEQSR put constraints on the delay over the path during real-time data transmission, the energy consumed during the transmission and error rate. Network lifetime is maximized at the cost of delay and error rate [11].

Alba Rozas et.al. discussed constraints and difficulties for QoS management, which can be network or application-specific. To add QoS awareness, the authors propose a modified clustering protocol called LEACH-APP, which considers the network's application into account for QoS management. LEACH-APP is designed for a network with different types of traffic originating from multiple sources. Different priority is assigned to a different type of traffic. The priority of each category can be dynamically modified. LEACH-APP increases the throughput of the system and decreases the latency. However, LEACH-APP does not guarantee QoS parameter fulfilment. Also, non-prioritized traffic suffers from inadequate resources. Computational overheads are also increased due to classification and priority-based forwarding of packets [12].

Parvinder Singh and Rajeshwar Singh highlighted problems raised due to improper cluster head selection in clustering algorithms like LEACH [13]. The authors concentrated on the selection of an appropriate cluster head using fitness function to reduce energy consumption and load balancing. For the selection of node as a cluster head, the node's distance from the base station, number of nodes in the cluster, the node's frequency of becoming a cluster head is considered. Repeated data transfer is also avoided. Simulation results show considerable improvements in energy consumption and QoS parameters. However, the authors didn't think about security and privacy issues during data transfer on channel. Fig. 1 describes the QoS parameters and their percentage considered by authors.

IV. CONCLUSION

From the literature survey presented in previous section, it has been observed that conventional QoS based routing algorithms suffer from the overhead of maintaining the tables and states, at each sensor node especially when the number of nodes is huge. Some routing algorithms do not have a packet prioritization scheme. The requirements of the QoS parameter may change with respect to the time or an application for which WSN is deployed. Initial QoS based routing algorithms ensure QoS to data packets generated by sensor nodes but fails to consider energy issues and hence these algorithms may be energy inefficient. Most of the QoS based routing algorithms may not handle network layer aggregation. Also, conventional QoS based routing algorithms require substantial state information to be stored at intermediate nodes. This information is related to the state of nodes and maintaining such information increases the burden on sensor nodes.

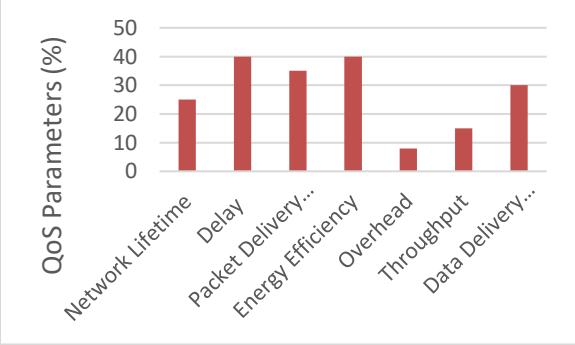

Fig. 1: QoS Parameter Weightage

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