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Routing protocols for wireless sensor networks: What the literature says?

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Abstract Routing in Wireless Sensor Networks (WSNs) plays a significant role in the field of environment-oriented monitoring, traffic monitoring, etc. Here, wide contributions that are made toward routing in WSN are explored. The paper mainly aims to categorize the routing problems and examines the routing-related optimization problems. For achieving the motive, 50 papers from the standard journals are collected and primarily reviewed in a chronological way. Later, various features that are related to energy, security, speed and reliability problems of routing are discussed. Subsequently, the literature is analyzed based on the simulation environment and experimental setup, awareness over the Quality of Service (QoS) and the deployment against various applications. In addition, the optimization of the routing algorithms and the meta-heuristic study of routing optimization are explored. Routing is a vast area with numerous unsolved issues and hence, various research gaps along with future directions are also presented.

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1. Introduction

Wireless Sensor Networks (WSNs) are recently developed to support plenty of applications, which include traffic control, home automation, smart battlefield, environment monitoring and many more. WSN incorporates various sensors that are distributed around a particular node for achieving the computational operations [51,41].

In WSN, routing is a very important task that is to be handled carefully. Routing technique is needed for sending the

data between the sensor nodes and the base stations, so as to establish communication. The main criterion, which is focused in this paper, is about the routing protocol that varies based on the application. The routing problem leads to decreased network lifetime with increased energy consumption. So, various routing protocols have been developed to minimize the energy consumption and to maximize the network lifetime. The routing protocols can be categorized based on the nodes' participation, clustering protocols, mode of functioning and network structure. The various challenges in routing include energy consumption, node deployment, scalability, connectivity, coverage, security. [52]. Fig. 1 explains the routing protocol of the wireless sensor networks.

The presented paper collectively reviews the routing analysis, which is performed in the wireless sensor networks such as the mobile ad hoc network, to maximize the network lifetime

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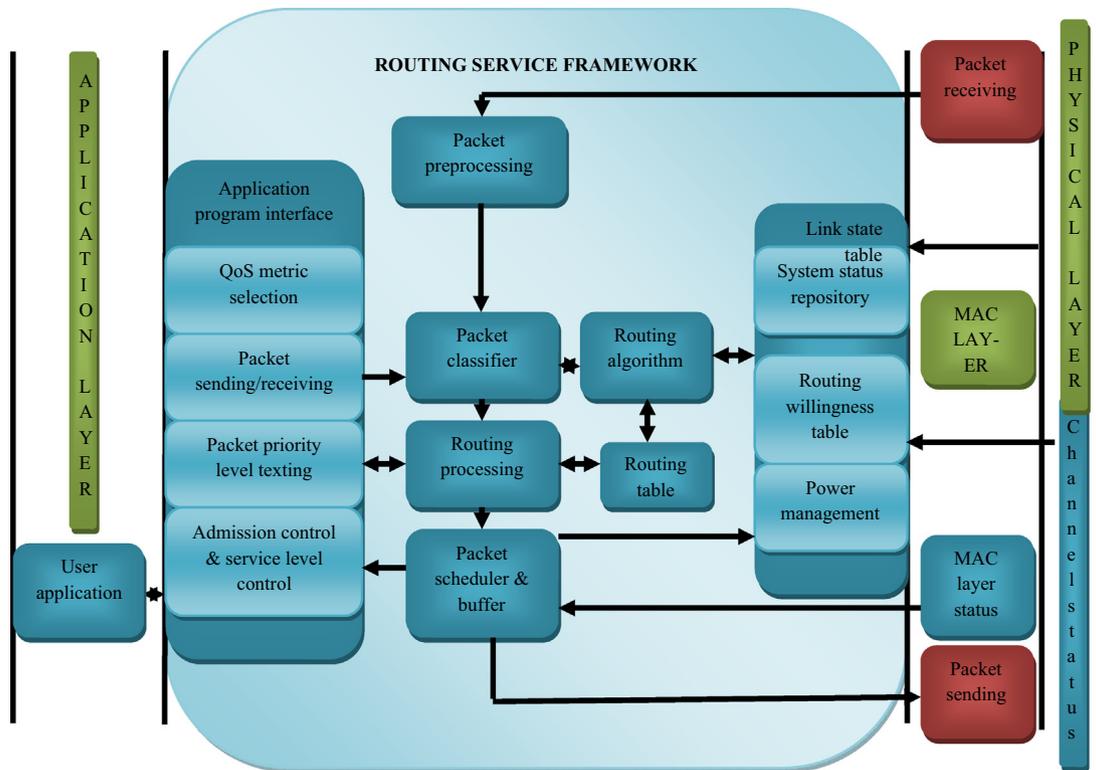


Figure 1 Architecture of the routing protocol in WSN.

and to decrease the energy consumption. The review is done using 50 research articles that occupy a supreme position in the leading journals of the past 10 years. The articles are acquired based on the top search results from the online library of the leading journals. The papers that are based on routing and its optimization are mostly selected. Section 2 is dealt with the chronological survey of all the papers that are collected. The collected papers are then used to select, categorize and describe various features. Section 3 gives a detailed analysis of the routing protocols, explaining about various simulators, tools, network configurations, QoS parameters and their applications. Section 4 reveals various optimization problems as well as the meta-heuristic procedures that solve them in the cloud environment. Next, Section 5 conveys the research gaps and the challenges. Finally, Section 6 ends the review with an informative conclusion.

2. Routing protocols for wireless sensor networks

2.1. Review chronology

Fig. 2 illustrates the chronology-based percentage calculation for routing in wireless sensor networks. In 2015, 42% of works are done in the field of routing, which is comparatively 4% higher than the works that are done in the consecutive years 2008, 2009, 2011 and 2012. About 8% works are done in 2014 and 2016. The predicted data represent the recent research and developments in the field of routing in wireless sensor networks. The routing protocols have been developed to face the challenges, which are caused due to the features such as energy, security, delay and error. The protocol that

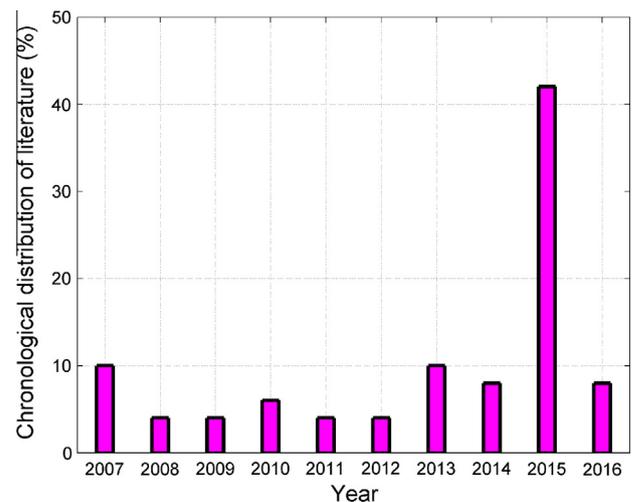


Figure 2 Development of routing protocols for WSN over the time period.

imparts energy efficiency has been developed more in number than the other featured protocols and it has peaked 38.46% in 2015. The percentage of works that pertain to the development of security-based routing protocols has been found to double every year, since 2013. Further, the number of delay-less protocols that has been developed from 2011 onward is found to exhibit a constant percentage of 6.67%, except for the year 2015. The interest shown toward developing a reliable protocol has dropped in 2012. However, the demand for error-free protocols has risen to about 50% in 2015.

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