

Literature Review on Protocols for Wireless Sensor Networks

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Abstract – Routing in Wireless Sensor Networks (WSNs) performs a substantial function within the discipline of surroundings oriented monitoring, traffic monitoring, and so forth. Here, extensive contributions which might be made in the direction of routing in WSN are explored. The paper especially targets to categorize the routing troubles and examines the routing-related optimization problems. Subsequently, the literature is analyzed based at the simulation surroundings and experimental setup, attention over the Quality of Service (QoS) and the deployment towards diverse programs. In addition, the optimization of the routing algorithms and the meta-heuristic examine of routing optimization are explored. Routing is a substantial place with severe unsolved problems and hence, numerous research gaps alongside future directions also are offered.

Index Terms – Routing, Wireless Sensor Networks, QoS, Optimization, Protocols.

1. INTRODUCTION

Wireless Sensor Networks (WSNs) are these days advanced to support lots of applications, which include site visitors manipulate, home automation, clever battlefield, environment monitoring and many more. WSN consists of various sensors which can be disbursed around a particular node for attaining the computational operations [11, 14, 21, 22, 23]. In WSN, routing is a completely important mission this is to be treated carefully. Routing approach is needed for sending the records among the sensor nodes and the base stations, with the intention to set up verbal exchange. The major criterion that is centered in this paper is about the routing protocol that varies based on the application. The routing problem leads to reduced community lifetime with improved power consumption. So, numerous routing protocols had been evolved to limit the energy intake and to maximize the community lifetime. The routing protocols may be classified primarily based on the nodes' participation, clustering protocols, mode of functioning and network shape. The numerous demanding situations in routing include electricity intake, node deployment, scalability, connectivity, coverage, protection [12]. Figure 1 explains the routing protocol of the Wi-Fi sensor networks. The present paper together critiques the routing evaluation, that's carried out within the wireless sensor networks inclusive of the mobile

ad hoc network, to maximize the community lifetime and to decrease the strength consumption. The review is achieved using 50 studies articles that occupy a perfect role in the main journals of the past 10 years. The articles are acquired based totally at the top search consequences from the net library of the main journals. The papers which might be based totally on routing and its optimization are typically selected. Section 2 is handled the chronological survey of all of the papers which might be accumulated.

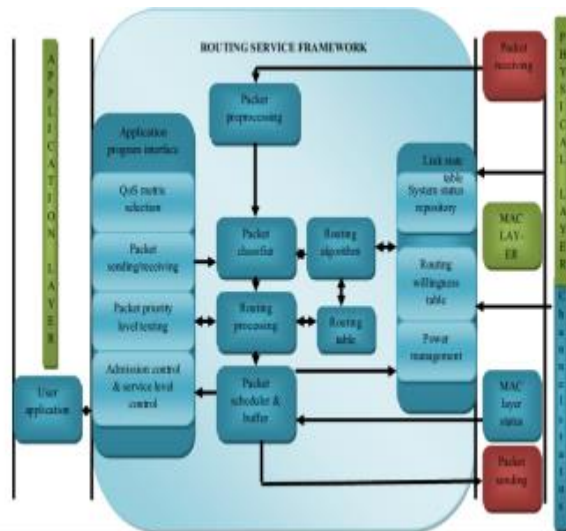


Figure 1: Architecture of the routing protocol in WSN

2. REVIEW OF LITERATURE

The routing troubles of WSN have been addressed in a big quantity of works. On reviewing the work, various functions inclusive of Energy, security, delay and error that pose demanding situations are recognized. This section gives a dialogue on the works, pertaining to those features, in a separate way.

2.1 ENERGY GREEN PROTOCOLS

In 2008, Wang et al. [1] have developed a multi-charge routing scheme to optimize routing in Distributed Source coding (DSC). The network performance become better by way of

energy scheduling, which satisfies the quit to end transmission price. In addition, they have got additionally proposed the strength utilization scheduling idea for efficient electricity optimization. Phan et al. [2] have worked on the joint cross-layer optimization method for green routing and energy distribution to meet the QoS necessities. They have determined that the optimization problem equals the two-step convex problem and the hassle of increasing the network lifetime is quasi convex. In 2007, Baek and Veciana [9] have focused at the change-off optimization trouble to obtain power performance in ad hoc community structures. The exchange-off optimization is carried out between the stepped forward spatial stability of energy burdens and the electricity fee of spreading traffic. Further, multipath routing became observed to reduce the possibility of power loss. Guha et al. [11] have tested strength-conscious routing schemes in wireless networks to suggest an honest coalition routing algorithm. They have located the organization sharing homes to vary for individual sharing. Lin et al. [18] have proposed routing algorithms for green power usage with top notch competitive ratio, that's asymptotically best to the wide variety of nodes. Kim et al. [14] have tried to maximize the wireless sensor networks and proposed the distributed joint routing and medium get right of entry to control algorithm. The addressed linear programming hassle has been avoided with twin composition. In 2009, Yang et al. [14] have optimized the routing and detection in fusion middle for route pre-computation and proposed 3 routing metrics. The joint optimization technique entails the Neyman-Pearson concept to resolve the strength-green routing trouble. Chamam and Pierre [15] have addressed two fundamental problems in wireless sensor networks, particularly multiplied community lifetime and much less energy dissipation. To meet these goals, they've optimally deliberate the sensors states in cluster-based sensor networks. The problem was viewed as an integer linear programming version and Tabu search heuristic has reduced the computational time. In 2010, Luo and Hubaux [10] have addressed the problem of durability of Wi-Fi sensor networks and proposed a primal-twin set of rules. They have additionally dealt with the joint optimization hassle of routing and joint sink mobility to elevate the network lifetime. Valentini et al. [19] have used the dynamic multi-objective routing set of rules to frame the easy hybrid routing protocol. Energy performance was assessed to locate the excellent course to the sink node.

In 2011 Li et al. [12] have studied the dual optimization problem of lifetime and distortion to increase a generalized electricity consumption version. The dual-stage optimization problem turned into solved the use of the gradient set of rules. In 2013, Habibi et al. [7] have proposed an optimization technique to evaluate the direct transmission's preference in a given node configuration or in a cooperative transmission. The ideal broadcasting strength and the most appropriate power values for the cooperative transmission section have been

recognized and the entire method can resolve the real-world problems. Shah and Lozano [16] have developed fixed tree Relaxation-primarily based algorithm and Iterative dispensed algorithm to solve the power green distribution issues. The problem became assumed as an optimization problem. The Iterative disbursed set of rules has presented right exchange-off among the power efficiency and the estimation accuracy. Hamadi and Chen [12] have applied the exchange-off many of the timeliness and the electricity consumption to manipulate the redundancy in heterogeneous wireless sensor networks. In the change-off optimization trouble, the excellent stage of redundancy in both the course and the supply become diagnosed to increase the community lifetime. In 2014, Long et al. [8] have evolved a brand new routing scheme, referred to as tree-based diversionary, to elevate the network lifetime. Chen et al. [10] have maximized the machine application with power allocation in routing. They have evolved a low complexity online solution and used a disbursed algorithm to check it. In 2015, Maddali [20] have proposed the multi-forged routing protocol to maximize the network performance. Alanis et al. [16] have developed an top-quality quantum-assisted algorithm, called non-dominated quantum iterative optimization set of rules, for the wireless multi-hop networks. The synergy a number of the quantum parallelism and hardware has significantly reduced the computational complexity. Zhang et al. [17] have proposed a multi-objective optimization trouble, which solves the alternate-off among load balancing and power performance. A Nash bargaining framework for inexperienced network routing became developed based on the sport theoretical version. The model is taken into consideration as a threat cost sport, because the overall performance of the version threatens the cost to decrease the fee. Gupta and Bose [11] have advanced dual minimum total electricity strategies to lessen the power intake in wireless sensor networks through maximizing the path lifetime and minimum weighted general strength method. Luo et al. [37] have saved energy through an opportunistic routing set of rules to growth the networks' lifetime. Tang et al. [38] have evolved a fee-aware at ease routing algorithm, which entails probabilistic-primarily based random on foot and electricity stability manage, to clear up the network lifetime difficulty. Ghaderi et al. [14] have solved the minimum power routing problem in Wi-Fi networks through presenting solutions to pseudo-polynomial complexity and its associated e-most beneficial approximation. Gupta et al. [15] have carried out an electricity green homogeneous clustering method at the Wi-Fi sensor community to maximise the community lifetime. Additionally, the Dijkstra's shortest path set of rules was brought to perform path optimization inside the clustered community. Rahat et al. [16] have supplied a singular multi-objective routing optimization for the sensor mesh networks to increase the networks' lifetime. The seek space with the shortest path pruning and a graph discount method become used to identify the routes absolutely. The best routes had been

were given the usage of the evolutionary set of rules. Hsu et al. [19] have advanced an opportunistic-primarily based routing model to clear up the power intake difficulty within the underwater sensor networks.

2.2 DELAY-MUCH LESS PROTOCOLS

In 2011, Basan and Jaseemuddin [3] have taken into consideration both the operations of the underlying directional MAC protocols and the bodily interference to expand a color war graph Abstraction. The evolved version renders a framework to examine the Wi-Fi link conflicts via comparing the stop-to-end delay transmission. In 2012, Dai et al. [14] have proposed a correlation-aware QoS routing set of rules to send the visible statistics with first-class of service. A correlation-aware internodes differential coding scheme turned into delivered to limit the site visitors hub and the average postpone in one delay tolerant networks and advanced an inter-landmark information routing algorithm, known as DTNFLOW. In 2014, Cheng et al. [11] have evolved an efficient QoS-conscious geographic opportunistic routing scheme for the wireless sensor networks. In terms of latency, the protocol has organized the prioritized sets.

In 2015, Tang et al. [5] have studied the routing set of rules of network-on-chip and introduced a unique metric, known as routing pressure, for evaluating the overall performance of the routing method. The traditional methods use degree of addictiveness as the metric measure; however it imparts very much less overall performance. So, the brand new metric degree that has the capability to expect congestion has been added. Jie et al. [15] have addressed the issue in the publishing or the subscriber gadget and proposed a unique algorithm, known as Hierarchy hybrid routing scheme. The proposed scheme became capable of deliver the nearby e-book to the core area and solves the difficulty in far off eBook routing into the threshold domain, permitting the gadgets to be routed apply to the subscribers. Zhang and Dong [19] have examined few issues in routing together with the put off in transmission and proposed a bypassing void routing protocol. The entire theory turned into based upon the digital coordinates to save you the void trouble, going on from the source to the destination.

Maddali [20] have evolved the multicast routing protocol for maximizing the network performance. For this have a look at, they have considered the parameter-delay to optimize the evolved protocol. Hsin et al. [13] have advanced the ACO-based Pheromone Diffusion adaptive routing framework, which relies upon at the Network facts vicinity framework and combines the spatial and the temporal community information. High performance development with greater significance in the direction of the delay measure became performed with their work. Chang et al. [15] have modified the ant colony optimization-based totally adaptive routing and proposed the nearby ACO-primarily based cascaded adaptive routing for boosting the load balancing and overall performance. The put

off distribution of the advanced approach has additionally been studied. Alanis et al. [16] have focused on routing in wireless multi-hop networks and proposed a most fulfilling quantum-assisted algorithm, referred to as non-ruled quantum iterative optimization algorithm. The give up-to-give up postpone parameter was taken into consideration to optimize.

Tang et al. [18] have proposed a fee-conscious secure routing algorithm to increase network lifetime and protection. The average delay of numerous protection parameters become addressed. Gupta et al. [15] have employed clustering technique and considered the postpone problem in wireless sensor networks to boom the network lifetime. Hsu et al. [19] have addressed the difficulty of long propagation put off in underwater sensor networks and evolved the opportunistic-primarily based routing. In 2016, Noh et al. [13] have examined the demanding situations in reliable underwater sensor events consisting of ocean current to expand a Hydro Cast, a hydraulic strain-based totally any cast routing protocol and the common cease-to-give up postpone performance become evaluated.

2.3 SECURE PROTOCOLS

In 2012, Liu et al. [19] have introduced a singular three phase disjoint routing scheme, called the Security and Energy-green Disjoint route, to hold network safety. The optimization hassle was solved via choosing apt routing techniques and subsequently, information sharing changed into covered. In 2013, Hamadi and Chen [12] have used exchange-off optimization in security and controlled redundancy in heterogeneous Wi-Fi sensor networks. In 2014, Saleem et al. [4] have advised a biologically inspired self-organized comfy self reliant routing that is predicated on progressed ant colony optimization to attain secure statistics transformation. Long et al. [8] have addressed the issue of supply region privacy and developed a new routing scheme, called tree-primarily based diversionary. Hide and are trying to find approach has generated fake supply routes to shield the source vicinity and diversionary routes have preserved privacy in the non-warm spot location. They have additionally detected a new direction-oriented attack inside the Wi-Fi sensor networks. In 2015, Frechette et al. [11] have proposed a capped hose model for robust community design traffic troubles. They have observed that the multi-hop routing designs are needed for both the hub and the shortest course. Tang et al. [18] have proposed a fee-aware cozy routing set of rules, related to probabilistic-based random walking, to clear up the safety difficulty. Ghaderi et al. [20] have prolonged the unmarried-hop bodily layer safety approach to multi-hop wireless networks.

2.4 RELIABLE PROTOCOLS

Despite the reliability of the routing protocol said to be characterized primarily based on definitely blunders, the reasons of error differ in numerous components. They rely on the reliability of the topology, hyperlink among the nodes,

protocol float and plenty of more. Yet, the discrepancy at the aforesaid factors ends in blunders in the communicating messages. Some vast protocols which are strong towards such mistakes are reviewed right here. In 2007, Lin et al. [28] have used packet shipping price because the metric measure and proposed a model to stumble on the efficiency of multi-hop radio networks. In 2010, Wu et al. [3] have worked on the routing schemes of multi-hop Wi-Fi networks, in particular concentrating at the software-oriented fine of service at some point of video transmission, and proposed a novel routing algorithm. They have also investigated the routing flexibility by using studying the PSNR stages and evolved a best-driven cross-layer optimization scheme to growth the video nice. The reliability of transport ratio in wireless sensor networks has additionally been discussed the use of a multi-objective algorithm, called dynamic multi objective routing set of rules, with the aid of Valentini et al. [9]. In 2011, Basan and Jaseemuddin [3] have considered the common packet supply ratio for studying the overall performance of the proposed underlying directional MAC protocols and the bodily interference, so that it will develop a shade battle graph abstraction. Li et al. [2] have taken into consideration the packet loss possibility degree to observe the effectiveness of the proposed approach in solving the twin optimization problem of lifetime as well as distortion and advanced a generalized energy consumption version. In 2012, Liu et al. [9] have added a novel 3-phase disjoint routing scheme, called the Security and Energy efficient disjoint path, for preserving the community security and growing the community lifetime. In addition, the packet Interception possibility changed into measured during the routing process. The Bit blunders fee with their energy transmission techniques has been simulated and compared by Habibi et al. [7], in 2013, to recommend an optimization technique that determines the direct transmission's desire with cooperative transmission. Shah and Lozano [16] have used mean square mistakes because the metric for their two algorithms, namely fixed tree Relaxation-primarily based algorithm and Iterative disbursed algorithm evaluation. In 2014, Cheng et al. [14] have investigated QoS routing in wireless sensor networks and delivered QoS-aware geographic opportunistic routing scheme. In phrases of packet speed ratio, the protocol has organized the prioritized units. Saleem et al. [4] have proposed a biologically-stimulated self-organized comfy self sufficient routing for increasing the network lifetime with low power intake and used the metric measures such as packet price and delivery ratio.

In 2015, Tang et al. [5] have studied the routing of WSN and brought a singular metric, referred to as routing strain, for evaluating the overall performance of the routing approach the usage of packet injection charge. Surendran and Prakash [7] have evolved a QoS-constrained fault tolerant ant look-beforehand routing algorithm for efficient MANET routing. It is vital to take the routing decisions for the maximization of

network lifestyles and the developed version has aided in detecting the best course and appearance-beforehand path pairs. In this take a look at, the packet transport ratio become used. Zhang and Dong [19] have solved the issue of routing together with packet transport ratio and proposed a bypassing void routing protocol. Maddali [20] have considered diverse parameters such as bandwidth and packet delivery ratio for optimizing the developed multicast routing protocol. Hsin et al. [13] have applied packet injection rate, along with other parameters, for analyzing the overall performance of the evolved ACO-based totally Pheromone Diffusion adaptive routing framework. Chang et al. [15] have used packet injection price as the metric measure for evaluating the performance of the ACO based cascaded adaptive routing and to enhance the weight balancing in addition to the overall performance. The BER evaluation has been carried out by Alanis et al. [16] to attain routing inside the wireless multi-hop networks the usage of the optimum quantum-assisted set of rules, referred to as the non-dominated quantum iterative optimization set of rules. Gupta and Bose [11] have extensively utilized the BER analysis for reading the performance of the evolved dual minimal general electricity strategies, in an effort to reduce the electricity consumption in the Wi-Fi sensor networks.

Luo et al. [17] have carried out electricity saving thru the opportunistic routing set of rules and as compared its overall performance with the existing route algorithms the usage of the receiving packet ratio. For the advanced price-aware comfy routing algorithm, Tang et al. [18] have used shipping ratio and other parameters to remedy the problems of network lifetime. Puggelli et al. [14] have developed a device, which allows in the deployment of wireless sensor networks and promotes fast prototyping. They have advanced a blended-integer linear program and a polynomial time heuristic to obtain the favored outcomes for the recognized troubles. They have completed OPNET simulation and used packet injection charge as the metric degree for comparing the network models.

In 2016, Noh et al. [13] have focused on the problems such as ocean present day and used the packet delivery ratio because the metric measure to develop a Hydro Cast, a hydraulic pressure based any cast routing protocol.

3. RESEARCH GAPS AND CHALLENGES

3.1 PRACTICAL CHALLENGES

1. Diverse topologies: In the hierarchical routing protocol of WSN, it's far vast to expand merged and a couple of topologies. Particularly, in hierarchical routing, executing and merging the cluster-primarily based topology with the grid based topology is a terrific assignment. All topologies have their very own deserves and demerits. Enhancing the performance with these deserves is pretty a tough venture.

2. Multiple assets/destinations: Except few routing algorithms, most of the routing algorithms permit communication between

a single source and destination. The packet collision might also bring about more than one source in addition to destination networks, because of the contention a number of the nodes. Hence, for averting the packet collision in those varieties of networks, a couple of forms of networks must be taken into account. Moreover, more than one sinks often cause data flooding, which the destiny researchers must substantially reduce alongside manipulate overhead.

3. Multi-objective routing: The algorithms which might be evolved for routing have to meet many application-particular necessities which include throughput, capability, coverage, give up-to-give up put off, real-time delay and collision. Therefore, developing a routing protocol that meets a couple of requirements to obtain optimization is one of the open demanding situations.

4. QoS with a couple of constraints: The QoS requirements such as outage chance, delay jitter, end-to-end postpones and bandwidth consumption needs to be considered to attain a flexible routing algorithm. Outage probability is certainly one of the QoS necessities of the cooperative routing algorithms. In a few Wi-Fi networks, assembly a single QoS requirement is itself a tremendous trouble.

5. Security routing: Most of the routing algorithms are designed to increase the insurance location and the community performances; however the safety problems are given much less significance. Hence, the means to obtain secure routing, without a loss in the community performance and the coverage location, is extraordinarily endorsed via making a node to have its have an effect on the signals of other nodes.

6. Energy call for: Energy can be obtained through vibration, solar or every other bodily criterion. The sensor nodes absorb the environmental power for organizing an effective communiqué. In the energy-restricted wireless networks, the electricity harvesting nodes are used because the relay nodes in cooperative diversity. From the literature survey, its miles located that the cooperative routing algorithms which might be associated with strength harvesting are very restrained.

7. Network packages: Lot of works is executed within the area of Wi-Fi sensor community packages. But, very few works are focused on the packages of other network area and they encompass the put off-touchy packages and the bandwidth-confined packages. So, the potential applications of cooperative routing such as LTE networks, cognitive radio networks, cellular networks, and wireless LANs may be taken into consideration for future have a look at.

8. Development structures: In this survey paper, its miles recognized that maximum of the routing algorithms are expected thru theoretical analysis and simulation. Very few algorithms are associated with the practical components of routing. So, executing these sorts of strategies paves a manner for future paintings.

3.2 FUTURE OPPORTUNITIES

The challenges which can be addressed in the present routing algorithms can be rectified by means of the use of soft computing and computational intelligence. The future opportunities can be as follows.

1. Design and programs: Wireless sensor networks are carried out in lots of regions, which encompass monitoring of the organic machine with tissue-implanted sensors and monitoring forest hearth with air-dropped sensors. The sensor nodes need to be in precise function for a few packages and some don't need the nodes to be unique. So, it's far critical to design the type, location and the wide variety of sensor nodes for future packages.

2. Sensor localization: Sensor localization refers back to the creation of area consciousness in all of the sensor nodes that are deployed at a specific point. Geometric-conscious routing may be used to reap correct information. Also, the localization methods that utilize the time-of-arrival of the alerts from the bottom stations are used in WSNs.

3. Routing based on strength focus: Maximizing the community lifetime in WSN is a chief factor, which is to be paid attention. Frequent recharging of the nodes isn't possible because of its price. For a few applications, the community lifestyles expectancy of numerous years is wanted. Routing includes the retrieval of the path of a message, which is communicated from a supply node in the direction of a vacation spot node. Among the 2 styles of routing techniques, the proactive Routing strategies contain table era and keep the routes without any route matching. But, within the reactive routing methods, the routes are subjected to computation. In addition, the hybrid of each the routing method is carried out within the densely deployed networks to keep away from massive memory intake of the routing tables. The memory usage can be reduced by community clustering too.

4. QoS aware routing: QoS may be described as the measure of the carrier quality that is worried with the stop-to-stop programs/users. The QoS parameters consist of packet loss, jitter, postpone, available bandwidth and equity. It is very huge to growth the network utilization with the QoS parameters and according with the application necessities.

4. CONCLUSION

Selecting the first-class direction is harder inside the field of WSN. The choice depends upon lot of parameters. Hence, various parametric features of the routing protocols were mentioned and analyzed in this paper. Further, the chronological survey reveals that about forty two% of the works are performed in 2015, which is comparatively excessive. The routing troubles arise in the course of records transmission from the supply node to the destination node. The electricity green problem, which constitutes about forty four%

of the works, has been discussed more. Trade-off optimization and the multi-goal routing optimization method have been utilized in numerous researches. Moreover, the meta-heuristic observe depicts that approximately 16% of the routing troubles were analyzed using the non-meta-heuristic procedures and only 10% have used the bio-inspired algorithms. Of all of the bio-stimulated algorithms, ACO has been notably carried out to resolve the routing problems. The destiny demanding situations encompass protection routing, electricity call for and multi objective routing.

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