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Survey: Multipath routing for Wireless Sensor Network

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Abstract— Reliability is playing very vital role in some application of Wireless Sensor Networks and multipath routing is one of the ways to increase the probability of reliability. More over energy consumption is constraint. In this paper, we provide a survey of the state-of-the-art of proposed multipath routing algorithm for Wireless Sensor Networks. We study the design, analyze the tradeoff of each design, and overview several presenting algorithms.

Index Terms—Multipath routing, Wireless Sensor network.

I. INTRODUCTION

In general Wireless Sensor Networks(WSNs) use batteries for energy supply and these batteries are irreplaceable as well as non-chargeable. So that energy efficient communication is vital for increasing the life time of the network. Many research papers discussed this issue as well as develop many routing protocol to overcome this problem [1], [2]. However, any node failure due to battery depletion will lead to loss of data in single path, in such case a new route needs to be discovered to send the data from source to destination; moreover this method requires extra energy cost with longer delay.

This problem can reduce by using the concept of multipath routing and it also reduces frequent routing updates with enhancement of data transmission rates. The other advantage of multipath routing is that it can provide load balancing of traffic due to this intermediate node consuming less energy, so that the network life time increases. Almost all the routing protocols are based on on-demand single path routing methods [3], [4]. All these differ from each other on how to forward multiple route requests and how to select multiple routes. Some algorithms consider the node energy while constructing the multiple paths [5], [6]. There are some problem with multipath routing e.g. they flood the route request to the whole network, due to this large communication overhead in the network and each node sends route discovery and data packets with the maximum power, which wastes energy if the recipient can receive the transmission data simultaneously, even if node disjoint multi paths are used, there is still a potential for collisions that result in high packet loss rate and bad data transmission performance [7]. There are some unique features of WSNs e.g. constrained power supply, limited computational capability and low-memory capacity leading towards new challenges that should be addressed in the design of multipath routing protocols. For giving improvement in data transmission reliability, fault-tolerant routing, controlling the load on network and Quality of Service (QoS) many researchers are using multipath routing in the last decade. We can also use

multiple paths routing to accelerate the data transmission reliability, there are generally to approach for it, in first approach we send multiple copies of the data to Base Station (BS), this method increase the increase the reliability and in second approach we make multiple copies of data send by different paths, this approach provides higher load balancing and consumes less energy in each intermediate node because the size of data is less as compare to single path routing. More over one other challenge in multipath routing is the involvement of nodes, for it there are three different techniques first is node-disjoint paths here in every path there is no common node. In second method there is no common link between two paths, the last technique uses some common path exist between two paths. In our proposed method we develop algorithm which provides multiple path for sending the same copy of data with node disjointed paths.

II. SURVEY

Intanagonwiwat et. al., [8] present a protocol which is query-based as well as has features of multipath routing, known as Direct Diffusion. This protocol also provides the path failure protection. However this protocol design routes after flooding the interest message, so that in network congestion is very high and much more energy is used while transmission of the data.

The concept of flooding for router generation is also used by Ganeshan D. et.al., [9] in the protocol named as Braided Multipath Routing. In this protocol two types of path reinforcement messages utilizes to construct partially disjoint paths. Here path construction is initiated through the sending of a primary path reinforcement message by the sink node to its best neighboring node towards the source node. When an intermediate node receives a primary path reinforcement message, it forwards this message to its best next-hop neighboring node towards the source node. This process is repeated until the primary path reinforcement message reaches the source node. In addition to the primary path construction process, source node and all the intermediate nodes along the primary path construct an alternative path around their next-hop neighboring nodes. This alternative path passes through the neighboring node, which is not included in the primary path. To this aim, whenever the sink and intermediate nodes send out the primary path reinforcement message, they also generate an alternative path reinforcement message and send this message to their next preferred neighboring node towards the source node. This process terminates upon reception of this message by one of the nodes along the primary path. As a result, each intermediate node along the primary path constructs a backup path around its next-hop neighboring node on the primary path via transmitting an alternative path reinforcement message. Through establishing a set of partially disjoint paths between the source and sink nodes, whenever the primary path fails to forward data packets towards the sink Node, one of the constructed alternative paths can be utilized to avoid data transmission failure. However, since this protocol utilizes only one path for data transmission, the end-to-end throughput is limited to the capacity of a single path. Besides, since this approach is designed based on the principles of Directed Diffusion, the drawbacks of Directed Diffusion can be also applied to this protocol. Wu, K et. al., [10] present a protocol, which consider the reliability and energy awareness with consideration of backup paths from each sensor node to the sink node. It is based on centralize approach where all the routing decisions taken by the sink node, whenever there is no active path towards the source node, a interest message sends to the sink node and it initiate a service path discovery process via flooding a service-path request message. When corresponding source node receives the service path request message, transmit a service-path reservation message towards the sink node for confirming the discovered path. All the intermediate node exists in reserve path must reserve residual energy for the successful transmission of data. After that sink node initiates backup path via flooding a backup path discovery message, during this process the intermediate nodes, which are not involved in discovered path broadcast the received message to their neighbors,

so that node disjoint path created for providing the fault tolerance in the case of service-path failure. Moreover this protocol providing the energy efficiency with fault tolerance but it suffer from the main disadvantages of alternate path routing technique, because we use one path at a time so that end to end delay depends on the single path. Deb, B et.al.,[11] proposed a protocol named as Reliable Information Forwarding Using Multiple paths in Sensor Networks (ReInForm). In this protocol, when a source node wants to forward its traffic it first determines the required reliability. After then source node add a field in packet. This field is known as Dynamic Packet State (DPS) and source sends multiple copies of the generated data packets over several paths. All the intermediate nodes use DPS to know how many copies of data should be transmitted to its neighbor. This process is repeated until data reach to the sink. ReInFrom provides higher reliability using transmission multiple copies of data, but it requires higher cost of energy consumption with bandwidth utilization, which is in contrast with the primary demands of WSNs. Lou W. et.al., [12] proposed a protocol named as N-to-1 Multiple Routing Protocol, which is based on the concept of discovering multiple node-disjoint paths from all the sensor nodes towards sink. For generation of routes flooding is used. There are mainly two steps first step initiated by sink through broadcasting a route update message, in this step construction of spanning tree is occurred and discover several paths from each sensor node to sink, there is no loop because generation of path from spanning tree. In second step generation of more paths exist with the use of multipath extension flooding technique. Finally sending node divides data in segment and transmits segments via different discovered paths beside it intermediate node uses adaptive per-hop packet salvaging technique to provide fast data recovery from node or link failures along with the active paths. More over all the constructed paths are located in physical proximity of each other and concurrent data transmission over these paths may reduce the network performance. Lou W. et. al.,[13] proposed a new protocol after adding hybrid data transmission technique in N-to-1 Multipath Routing Protocol and this protocol is known as H-SPREAD. H-SPREAD improves the security and reliability of data in WSNs. In this protocol the data is secured because it use threshold secrete sharing scheme. In this scheme data can be safely transmitted to sink with handling of some nodes or path failed. Here the source nodes divides data packet in multiple shares with the help of secrete sharing strategy and sends these shares towards sink via different paths. Moreover this protocol suffers from wireless interference. Because it use N-to-1 multipath routing scheme to generate the routes, so it consist all the disadvantages of N-to-1 multipath routing scheme. Huang X. et. al., [14] proposed a protocol named as Multi-Constrained QoS Multipath Routing (MCMP). This protocol is mainly providing the soft-QoS in terms of delay and reliability with the help of using deterministic linear programming. MCMP maps the reliability and delay of the link along different paths with the following two equations:

$$L_i^d = \frac{D - D_i}{h_i} \qquad (1)$$

$$L_i^r = \sqrt[h_i]{R_i} \qquad (2)$$

L_i^d And L_i^r represents the delay and reliability requirement of node i. Delay D_i represents the delay experienced by packet at node i as well as R_i represents the reliability requirement assigned to the path passing through node i and h_i is the hop count from node i to sink. Eq. (1) is utilized by all the nodes at route discovery process, and each node selects one or a set of its neighboring nodes to satisfy the reliability. This protocol is suffered from data redundancy problem at sink node because

Here same copy of data sends to the sink from source. Furthermore partially disjoint paths are usually located nearby so high data rate transmission causes by significant interference. Bagula A.

et.al, [15] modified the MCMP [14] with respect to energy-efficient. This protocol is named as Energy Constrained Multipath Routing (ECMP), this protocol also provide the reliability and delay constraint of the data source because it is the extension of MCMP. The result shows that it provides the feature of MCMP with less energy consumption. Moreover all the disadvantages of MCMP exist in this protocol. Recently Ben-Othman, J et.al, proposed a energy efficient routing protocol [16], which also satisfy the reliability and delay requirements of real time application. The name of this protocol is Energy-Efficient and QoS-based Multipath Routing Protocol (EQSR).

III. CONCLUSION

In this paper, we take an initial step to overview the proposed multipath routing algorithms in WSNs. Multipath routing plays a vital role to provide fault tolerant. Here we also discuss a set of coding techniques based multipath routing in detail. In addition, groups of multipath routing protocol design issues. Such as major design goals, challenges and evaluation metrics are presented in the paper.

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