An Efficient Technique for Multipath Routing Protocols Wireless Sensor Network

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Abstract— Nowadays the requirement of network is increasing quickly. The ever increasing usage of such network need additionally demands fast recovery from network failures. Multipath routing is one in all the most promising routing schemes to accommodate the several requirement of the network. A wireless sensor network could be a large collection of sensor nodes with restricted power supply and affected computational capability. Because of the restricted infusion limit and high density of sensor nodes, packet forwarding on sensor networks is typically performed through multi-hop information transmission. So, routing in WSNs has been considered a very important field of analysis over the past decade. Today, multipath routing approach is wide employed in wireless sensor networks to better network performance through efficient utilization of accessible network resources. Consequently, the main aim of this paper is to developed the concept of the multipath routing approach and its basic challenges, also because the basic motivations for utilizing this method in wireless sensor networks. Additionally, multipath routing protocols, that are specifically designed stand for wireless sensor networks. We highlight the first motivation behind the development of every protocol category and make a case for the operation of various protocols in detail, with emphasis on their benefits and drawbacks. Finally, we establish open issues for any analysis into the development of multipath routing protocols for WSNs.

Key words: Multipath routing; WSNs; Concurrent multipath routing; Alternative path routing; Load dis-tribution; Energy efficiency; Reliability; QoS

I. INTRODUCTION

Multipath routing is employed to find out multiple pairs of paths between source and destination. The scheme provides robustness [2], load balancing [3], and security [4]. Techniques developed for multipath routing supported employing multiple spanning trees or directed acyclic graphs (DAGs) [5]. The packet has to be dropped once adjacent nodes are not accessible. This dropping takes place due to potential looping of packets once transferred from one routing table to a different. It provides quick recovery from single-link failures give over one forwarding edge to route a packet to a destination. The techniques classified on the premise of the character during which the backup edges are used.

Multipath routing has drawn intensive attention in MANETs and WSNs recently. The dense preparation of nodes in MANETs/WSNs makes the multipath routing a nature and promising technique to deal with the frequent topological changes and consequently unreliable communication services. analysis efforts have conjointly been created exploitation multipath routing to enhance the robustness of information delivery [22], to balance the traffic load and balance the ability consumption among nodes [9, 23], to reduce the end-to-end delay and also the frequency of route discoveries [7,16], and to enhance the network security [10], etc. two primary technical focuses during this area are, the multipath routing protocols that are able to realize multiple paths with the required properties, and the policies on the usage of the multiple paths and also the traffic distribution among the multiple paths, that very often involve coding schemes that help to separate the traffic.

A. Advantages of Multipath Routing:

1) Bandwidth Aggregation:

By ripping information to a similar destination into multiple streams, every routed through a unique path, the effective bandwidth will be aggregated. This strategy is particularly useful once a node has multiple low bandwidth links however needs a bandwidth larger than an individual link will provide.

2) Reduced End To End Delay:

For wireless networks using single path on-demand routing protocols, a route failure means a new path discovery process has to be initiated to search out a new route. This results in a route discovery delay. The delay is reduced in multipath routing because backup routes are known during route discovery. End-to-end delay can also be reduced as direct results of larger bandwidth accessible with the utilization of Multipath routing. Authors in [6], planned a protocol for multipath video streaming over WSNs. Multiple disjoint paths can do high throughput and desirable delay and meet the QoS requirement of transmission streaming.

3) Load Balancing:

The main goal with load balancing is to create a lot of use of accessible network resources so as to reduce the chance of traffic congestion. Once a link becomes over-utilised and causes congestion, multipath routing protocols will prefer to divert traffic through alternate paths to ease the burden of the congested link. Load leveling will be achieved by spreading the traffic on multiple routes. This could alleviate congestion and bottlenecks. Hopefully this could lead to less delay and packet loss. It may but lead to extra propagation delay if the alternative routes are badly chosen. Some applications are very sensitive to delays (e.g. VoIP). Others are a lot of sensitive to packet loss. The utility of multi-path routing to realize period of time enhancements by load balancing and exploiting cross-layer data in WSNs is investigated in [7].

4) Alleviating Network Congestion:

Transmission collision occurred at nodes that receive packets from multiple nodes at a similar time greatly reduces the network performance. Therefore, the services provided by the sensor network also are greatly wedged. In [8], authors planned a unique mechanism to search out

multiple-paths between one sink and multiple-sources with the thought of reducing collision occurred at nodes that are receiving and forwarding packets on behalf of the source nodes. Previous multiple path routing strategies use flooding for route discovery and transmit information with most power in spite of want, which results in waste of energy. Moreover, usually a significant drawback of collisions among multiple paths arises. Authors in [9] proposed an energy efficient and collision aware (EECA) node-disjoint multipath routing algorithmic rule for wireless sensor networks. With the help of node position data, the EECA algorithm attempts to search out two collision-free routes exploitation affected and power adjusted flooding and so transmits the information with minimum power required through power control element of the protocol.

5) Improving the Fault Tolerance:

The WSNs are usually subject to high failure rates because of environmental noise and obstacles, and nodes could die because of battery depletion, environmental changes or malicious destruction. In such an atmosphere, reliable and energy-efficient information delivery is crucial because sensor nodes are usually operated with limited battery power on error-prone wireless channels. In ancient WSNs, faults would either still occur at high frequencies or stop occurring when a particular moment in time [11]. The high-frequency fault occurrences have a additional serious impact on WMSNs than on ancient WSNs due to the large volume of the video or audio streams. The matter of path breaks because of node failure leads to the need of extra routing overhead to search out different path that reduces the energy of the nodes and affects the network time period. Routing protocols should be designed to realize fault tolerance within the presence of individual node failure whereas keeping energy consumption at a minimum. This reduces the probability that communication is disrupted just in case of link failure.

6) Quality of Service (Qos):

Multipath routing is to produce quality of service, additional specifically, to reduce the end-to-end delay, to avoid or alleviate the congestion, And to enhance the end-to-end throughput, etc. it has been shown that multipath routing helps considerably in providing QoS by reducing the end-to-end delay for packet delivery [7]. The reduction within the end -to-end delay is not that intuitive and is attributed to multiple factors. Notice that the end-to-end delay is that the latency between packets sent at the source and received at the destination. Besides the standard transmission delay, propagation delay, and queuing delay, that wide exist altogether IP networks, there are two varieties of latency caused significantly by ad hoc on-demand routing protocols. One is that the latency the protocol takes to find a route to a destination once there is no acknowledged route to it destination. This type of latency is because of the on-demand behavior of the routing protocol and exists altogether such protocols. Multipath routing effectively reduces the frequency of route discovery thus the latency caused by this reason is reduced. The other one is that the latency for a sender to "recover" once a route being employed breaks. The latency ensuing from broken routes can be very large because the number of latency is that the addition of the subsequent three components - the time for a packet to travel the route to the node directly before the broken link, the time for that node to discover the broken link, and also the time for a route error message to travel from that node back to the source node. Among them, the time to discover a broken link can be very large because the failure of the link will only be determined when having created a certain variety of makes an attempt to transmit the packet over the broken link however failed to receive a passive or explicit acknowledgement of success. This latency caused by route errors could be a significant factor within the overall packet latency.

7) Security:

A few efforts are created to enhance the network security by exploitation multipath routing. Whereas used for security purpose, multipath routing is usually combined with secret sharing cryptography. Therefore, schemes combining multipath routing and secret sharing techniques usually involve the ripping of a secret by secret sharing scheme and also the delivery of the shares by multipath routing. By this implies, the trust is distributed to multiple nodes/paths within the network and also the system is created additional resilient to a collusive attack by up to an explicit variety of compromised nodes.

II. MULTIPATH ROUTING TECHNIQUES

This section provides a brief overview of the various categories of Multipath routing protocols appropriate for sensor networks.

A. Classification of Multipath Routing Techniques:

There are three main phases of multipath routing: path discovery, traffic distribution, and path maintenance. The path discovery section determines the accessible paths for a source-destination pair. Throughout the traffic distribution part, the amount of paths for distributing traffic is chosen. Path maintenance is responsible for create paths when the initial path discovery. It will be initiated either when every path failure or once all the paths have failing. By looking into the connected add Multipath Routing within the past, Multipath protocols will be classified in two ways that, as shown in Fig. 1, supported the way the routing paths are established throughout the path discovery part and on the way the routing paths are chosen to distribute the traffic. Supported the application desires, the protocol could use characteristics of both strategies of classification.

B. Path Discovery Based Multipath Routing:

During the path discovery method, disjointness will be used as a criterion by a protocol to search out possible paths; this parameter describes the independence of the paths in terms of shared resources. The set of paths between a source node and a destination node will be classified supported the degree of path disjointness, namely non-disjoint paths and disjoint paths.

1) Non-Disjoint Ways:

Non-disjoint paths, additionally mentioned as joint multi-paths, will have links and nodes in common with any loop-free paths.

2) Disjoint Paths:

The Disjoint Multipath method attempts to search out disjoint paths supported the degree of independence of every path. These paths will be classified as follows:

a) Link-Disjoint Multipath:

Link-disjoint paths discuss with set of paths that have not any common links however could share some common intermediate nodes. In [13], authors given a multipath routing scheme to distribute the traffic over the multiple link-disjoint paths supported the path deputies principle one neighbor one deputy service, completely different neighbour different deputy service.

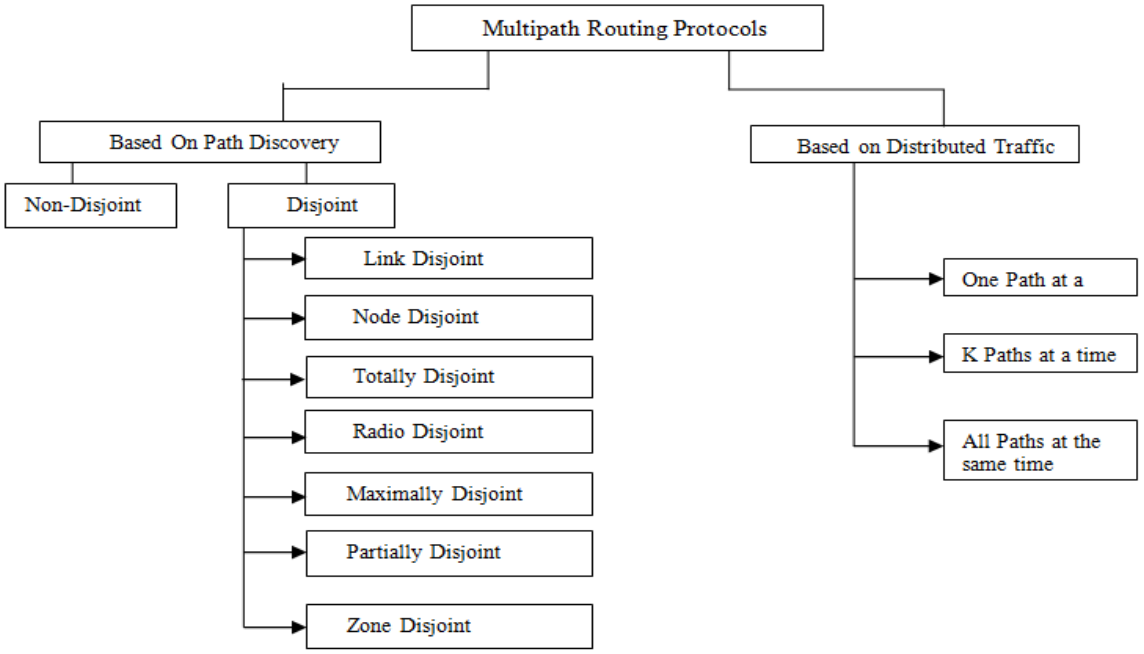

Fig. 1: Classification of Multipath Routing Techniques

b) Node-Disjoint Multipath:

This refers to the set of paths within which every path does not share any nodes apart from the source and also the destination nodes. Therefore they are unaffected by failure on the other path. Most existing routing protocols are not very sensible for sending multimedia system contents in resource affected sensor networks. In [14], an optimized nod-disjoint multi-path routing scheme is proposed resulting in throughput improvement and load balancing for sending multimedia system content. In [15], authors proposed TPGF is that the initial multi-path routing protocol within the WMSNs field. It focuses on exploring the most range of optimal node-disjoint routing paths in network layer in terms of minimizing the path length and also the end to end transmission delay also as taking the limited energy of WSNs into consideration.

c) Totally Disjoint Multipath:

While concurrent information transmissions occur, the set of distinct paths that are zero-edge connected, and therefore do not interfere, are mentioned as completely disjoint paths. In [17], a to-tally disjoint multipath routing in multi-hop wireless net-works that gives an analysis of the throughput during a multipath routing strategy considering the impact of interference is given. Here the author‘s focuses on networks with fixed and non-energy affected wireless backbone. The authors adopt an incremental approach to deal with the problem by initial considering the interference between a single source-destination pair and next between multiple sources and destinations.

d) Maximally Disjoint Multipath:

A set of node-disjoint paths that maximises a disjoint charac-In [17] authors have investigated multipath routing algorithm and compare them with single path supported the expectation of lifetime of every of the disjoint multipath and decorated multipath mechanism. In [18], the authors planned the Classical node-disjoint multipath and a completely unique braided multipath that consisted of part disjoint different paths to demonstrate the energy/resilience trade-offs of those mechanisms for each independent and geographically correlate failures. The multipath routing techniques designed for ad hoc network do not apply to the sensor network because of the lack of global ID in sensor networks. In [19], the authors propose a unique approach called Label-based Multipath Routing (LMR) which will with efficiency find a disjoint or segmented backup path to produce protection to the working path once com-pared to the disjoint or braided multipath strategies.

e) Zone–Disjoint Multipath:

This refers to the set of paths within which data communication on one path will not interfere with the data communication on different path. High-rate streaming in WSN is needed for future applications to produce high-quality data of field of battle hot spots. Though recent advances have enabled large-scale WSN to be deployed supported by high-bandwidth backbone network for high-rate streaming, the WSN remains the bottleneck because of the low-rate radios used and therefore the effects of wireless interferences. Authors in [20] initial proposed a method to evaluate the standard of a path set for multipath load balancing, taking into thought the effects of wireless interferences which nodes could interfere beyond communication ranges. Second an interference- minimized multipath routing (I2MR) protocol that will increase output by discovering zone-disjoint paths for load balancing, requiring minimal localization support. Third, propose a congestion control scheme that additional will increase

throughput by loading the paths for load balancing at the highest potential rate supportable. Finally, validate the path-set analysis technique and conjointly measure the I2MR protocol and congestion control scheme by comparison with AODV protocol and node-disjoint multipath routing (NDMR) protocol.

C. Distribution of Traffic-Based Multipath Routing:

There are varied methods for allocating traffic over accessible paths. A path selection algorithmic rule is employed to select a subset of accessible paths consistent with certain qualities of the paths and supported the purpose of the multiple paths. The first one could be a back-up path is set up at the same time because the main path for emergency. Once the most paths are down, the source node uses the back-up path. Secondly, multiples paths will be used to handle congestion and keep load balancing. Once a path has significant traffic, different paths are utilised to reduce the congestion. Finally, multiple paths will be used to increase the end-to-end performance (e.g., high throughput and low delay) by transporting data through multiple paths.

1) One Path at a Time:

This refers to a collection of paths within which the traffic is forwarded exploitation just one path that has the most effective metric; the other discovered paths are kept as backups.

2) Simultaneous Use of K- Ways:

This refers to a collection of paths within which the forwarding of traffic would occur over K distinct paths at the same time. In [21], author's focuses on delivering the packets at de-sired reliableness supported the data detected employing a multipath routing technique. The data is delivered reliably exploitation the less variety of transmissions of information packet. Only restricted numbers of paths are used between the sources and also the destination supported criticality of the data to be delivered instead of exploitation all possible paths. Authors in [22], proposes that Multipath information Transfer protocol provides coincident multiple paths for communication between any two nodes. This algorithmic rule distributes the work among the nodes uniformly prolonging the lifetime of WMSN.

3) All Paths at the Same Time:

This refers to a collection of paths during which the traffic is forwarded on all of the accessible multiple paths at the same time to more reduce delivery time and therefore increasing the delivery ratio.

III. APPLICATION RELATED ISSUES

Nowadays, multipath routing is widely thought of as a promising approach to deal with the limitations of wireless sensor networks and it may be used to improve the performance demands of different applications. However, whereas a multipath routing approach improves the performance requirements of a particular application, it should negatively have an effect on the performance needs of another application. Example, as transmitting multiple copies of data packets will increase delivery reliability, it also reduces network time period and capability because of the imposed overhead. Therefore, choosing a right multipath routing approach is extremely application dependent and involves the trade-off between several performance parameters. Table 1 most motivation and used approaches behind the development of the protocols given within the previous section.

Path Utilization	Motivation	Approach	Protocols
Alternative Path Routing	Fault-Tolerant Routing	Path Switching	Directed Diffusion, Braided Multipath Routing, Reliable and Energy-Aware Routing
Concurrent Multipath Routing	Reliable Data Transmission	Copying the Original Packets	ReInForm, MMSPEED, MCMP, ECMP
		Erasure Coding	H-SPREAD, DCHT, EQSR
		Packet Salvaging	N-to-1 Multipath Routing
	Efficient Network Resource Utilization	Load Balancing	Energy-Efficient Multipath Routing, AOMDV-Inspired Multipath Routing, I2MR, MR2, EECA, LIEMRO

Table 1: A presentation multipath routing protocols

As mentioned earlier, the first motivation behind utilizing multipath routing approaches in wireless sensor networks was to enhance path resilience against route failures through the alternative path routing technique. Since, the key idea during this approach is to use one path for information transmission and reserve the alternative paths because the backup paths within the case of route failures, these protocols suffer from a similar main disadvantage of single-path routing approaches, i.e., limited end-to-end capability. The improvement of this approach over single-path routing is that this method will increase network performance whereas it also reduces the frequency of the route discovery process. As partially disjoint paths will give fault-tolerant routing through the alternative path routing approach with minimum cost, most of the multipath routing protocols during this class use this type of path disjointedness to reduce the imposed overhead by the route discovery and maintenance processes.

Some of the essential applications (e.g., battlefield surveillance and intrusion detection) need high data transmission reliability; consequently, the second group of multipath routing protocols is especially designed to deal with the time-varying properties and unreliableness of low-power wireless links. These protocols offer reliable communication through utilizing the path diversity nature of multipath routing approach and introduce data redundancy

into the data delivery method (e.g., sending multiple copies of original packets, or erasure coding). though the efficiency of those protocols in renovate data transmission reliableness is incontestable through intensive performance evaluations [12], still, they suffer from the high overhead caused by sending multiple copies of data packets and utilizing secret writing scheme.

Due to the resource limitations of sensor nodes and low capability of individual paths, recently, Multipath routing approach is generally used to extend network capability underneath high traffic conditions e.g., transmission streaming [25]. On another hand, once information is transmitted through multiple near paths, the capability of every path reduces because of the interference caused by different paths. From the MAC Layer point of view, a node related to a path could sense the carrier busy whereas neighbouring node in an adjacent path is sending. Additionally, an in progress transmission on a path is also affected by the interference induced from near paths. These problems cause higher medium access delay, enhanced packet loss and elevated end-to-end latency of the packets being transmitted to the sink node. Therefore, the utilization of concurrent multipath routing cannot essentially satisfy the performance demands of high data rate applications. Whereas the protocol designer should think about the specified end-to-end latency and capability of the underlying applications to determine a tradeoff between the inter-path distances and therefore the length of every path, special MAC layer mechanisms is also needed to schedule per-hop transmissions supported the experienced interference.

IV. CONCLUSION

This paper provides a comprehensive analysis of the foremost recently introduced multipath routing protocols for wireless sensor networks. Today, multipath routing techniques are considered an efficient approach to enhance network capability and resource utilization under significant traffic conditions. With respect to the recent advances within the development of multipath routing protocols for wireless sensor networks, there is a requirement to analyse the significance also because the detailed operation and classification of the proposed approaches. To fill this gap, during this paper we have tried to identify the challenges referring to the design of multipath routing protocols for wireless sensor networks. In addition, we have highlighted the most benefits of exploitation multipath routing approach to satisfy the performance needs of various applications.

This paper also introduces a new classification on the multipath routing protocols designed for wireless sensor networks. The provided classification is performed supported the used path utilization strategies which will be employed by multipath routing protocols to achieve various performance advantages. Detailed operational characteristic of the present multipath routing protocols associated with the various categories. Multipath routing will reduce the requirement for route updates, balance the traffic load and increase the information transfer rate during a WSN, improving the use of the limited energy of sensor nodes. We conjointly provided varied different proposals of Multipath routing discussed in paper. It is discovered that there is an urgent need to develop routing protocols that are additional energy efficient, are more reliable and have higher control regarding the QoS needs of transmission data. During this paper we have covered all the aspect of Multipath Routing and Qos that is important for requirement for transmission data transfer over wireless sensor Network.

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