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Reliable and Power Relaxation Multipath Routing Protocol for Wireless Sensor Networks

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Abstract. Routing in sensor network is very challenging task for wireless sensor networks. Generally the ideal sensor networks should provide reliable, power consumption, multipath routing, less delay efficient path discovery and long lifetime node. Therefore in this paper, relax multipath routing protocol is proposed for wireless sensor network successfully. The proposed relax protocol utilizes the LWFEC technique by adding the data redundancy. The relax protocol increase the protocol reliability and is able to recover from the path failure.

Keywords- Multipath Routing, Forward Error Correction, Relaxation Effect.

1. Introduction

These routing techniques can be classified according to the protocol as follows. The negotiation based protocols eliminate the redundant data by include high level data descriptors in the message exchange. In query based protocols, the sink node initiates the communication by broadcasting a query for data over the network. The QoS based protocols allow sensor nodes to make a tradeoff between the energy consumption and some QoS metrics before delivering the data to the sink node.

Finally, multipath routing protocols use multiple paths in order to improve the network performance in terms of reliability and robustness. In these approaches, multiple copies of data are sent along different paths, allowing for resilience to path failures. Load balancing can spread energy utilization across nodes in a network, potentially resulting in longer lifetimes. Duplicating data delivery along multiple paths can result in more accurate tracking in surveillance applications, at the cost of additional expense in energy. RELAX protocol for WSNs to recover from path failures and achieves load balancing through the distribution of the traffic across a set of node-disjoint paths in order to efficiently use the node's battery power.

RELAX uses the residual energy, node available buffer size, and Signal-to-Noise Ratio to predict the next hop through the path construction phase. RELAX protocol adds data redundancy to the original data message and uses multiple paths to transmit the data. RELAX splits up the transmitted message into number of segments of equal size, add XOR-based FEC codes, and then transmits it across multiple paths simultaneously. This increases resiliency to path failures and increases the probability that an enough portion of the packet is received at the destination to recover the original data message.

2. Designing of WSNs Using Relax

2.1. Battery Relaxation

The lifetime of a sensor node is determined by the lifetime of the battery used to supply power to this sensor node. Therefore prolonging the lifetime of the battery prolongs the lifetime of the sensor node. The operation of the battery depends on different factors. These factors include battery dimension, type of electrodes, diffusion rate of the active materials in the electrolyte, discharge rate, etc. The battery

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performance with regard to discharge pattern depends on two effects: i) the capacity effect which depends on the battery actual capacity and the discharge rate; ii) the recovery effect due to the battery recovery during idle periods.

The battery relaxation periods can be used to mitigate the effect of high discharge rates on the battery lifetime. If the current drawn from a battery is reduced or completely cut-off, the diffusion and transport of active materials catches up with the depletion caused by the discharge. This phenomenon is called the relaxation effect, and enables the battery to recover a portion of its lost capacity. We try to utilize this effect in prolonging the sensor network lifetime through prolonging the battery lifetime. We assume that each sensor node in the network is powered by two batteries, where each battery supplies power to the sensor node for a certain amount of time. Operating the sensor node this way gives the battery a chance to recover a portion of its lost power during the rest periods, which significantly increases the battery lifetime, and hence increasing the lifetime of the whole sensor network.

2.2. Link Cost Function

The link cost function is used by the node to select the next hop during the path discovery phase. Let *Nx* be the set of neighbors of node *x*. Then our cost function includes an energy factor, available buffer factor, and interference factor with appropriate weights (á, â, and ã).

Next hop = max yå*Nx {*á ***E, y*** + â ***B, y*** + ã ***I, xy},***

Where, E-*Eresd, y* is the current residual energy of node *y*, where *y* å *Nx*, B-*buffer*, y is the available buffer size of node *y*, and I-*interference*, xy is the SNR for the link between nodes *x* and *y*. The residual energy of node *y* is considered but not *node x*, because node *y* consumes energy for data reception and transmission if it is selected as a next hop for node *x*. We do not consider node *x*, because whatever node *y* is, node *x* still needs to spend the same amount of energy on data transmission. The total cost for a path *P* consists of a set of *K* nodes is the sum of the individual link costs *l(xy)i*, i å K along the path refer [4]&[5].

2.3. Paths Discovery Phase

The sink node starts the multiple paths discovery phase to create a set of neighbors that able to forward data towards the sink from the source node. Fig 1.1 shows the timing diagram of path discovery .The constructed multipaths are node-disjoint paths. In multipath routing, node-disjoint paths are usually preferred because they utilize the most available network resources, and hence are the most fault-tolerant. If an intermediate node in a set of node-disjoint paths fails, only the path containing that node is

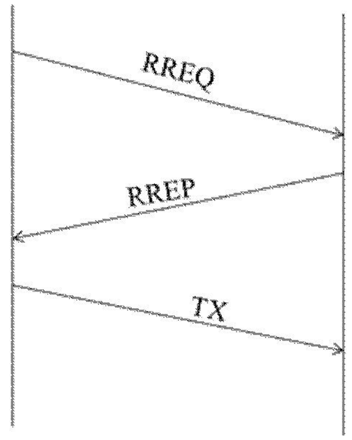

Fig1.1: Timing diagram

affected, so there is a minimum impact to the diversity of the routes. The path discovery procedure is executed according to the following phases:

2.3.1. Initialization phase

Fig 1.2 shows Each sensor node broadcast a HELLO WORLD message to its neighbours in order to have enough information about which of its neighbours can provide it with the highest quality data. Each sensor node maintains and updates its neighbouring table during this phase. The neighbouring table contains information about the list of neighboring nodes of the sensor node. The link quality field is expressed in terms of signal-to-noise ratio for the link between the source node and its neighbour. Hop count gives the distance in hops for the message from its originator.

2.3.2. Primary Path Discovery Phase

After initialization phase, each sensor node has enough information to compute the cost function for the links to its neighbours. Then, the sink node locally computes its preferred next hop node using the link cost function, and sends out a RREQ message to its most preferred next hop. Similarly, through the link cost function, the preferred next hop node of the sink computes locally its most preferred next hop in the direction of the source node, and sends out a RREQ message to its next hop, the operation continues until source node.

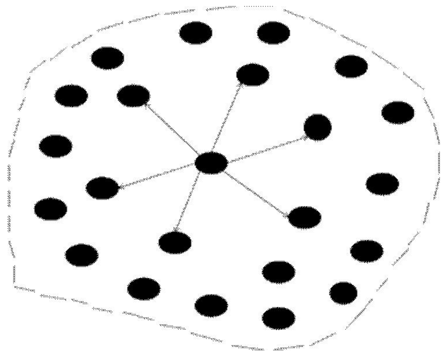

Fig1.2: Broadcast a HELLO packet to the neighbours

2.3.3. Alternative Paths Discovery Phase

For thesecond alternate path, the sink sends alternate path RREQ message to its next most preferred neighbour. To avoid having paths with shared nodes, we limit each node to accept only one RREQ message. For those nodes that receive more than one RREQ message, only accept the first RREQ message and reject the remaining messages. Node has been included in the primary path, then node is included in the alternate path and then those nodes are communicating with an INUSE message

2.4. Route Refreshing

To keep multiple paths alive, the source node periodically floods a KEEP ALIVE message over multiple paths to keep them alive. The frequency of the KEEP ALIVE message determines how quickly the routing protocol recovers from failures on the primary path.

2.5. Traffic allocation and Data Transmission

After multiple paths have been discovered, the source node begins to transmit data messages to the sink. To deliver data to the sink node, we use a subset of the available paths to transfer the message in order to distribute the load over the nodes, and to avoid the fast battery drains because of the extensive use of the same path to carry a long message for long time. We split up the message into small parts, add error correction codes, and then transmit it across multiple paths simultaneously to increase resiliency to path failures and ensure that an essential portion of the packet is received at the destination without incurring excessive delay through data retransmission. At the sink node, the parts are collected, reassembled, and the original message is recovered.

2.6. Paths Selection

After the completion of paths discovery phase and the paths have been constructed , we need to select a set of paths from the N available paths to transfer the traffic from the source to the destination with a desired bound of data delivery given by á shown in fig 1.3.

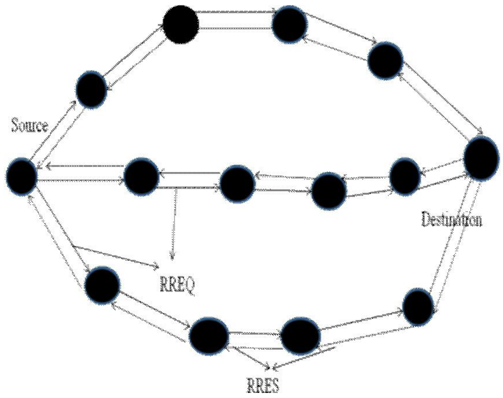

Fig1.3: Path selection from sink node to destination

To find the number of required paths, rate pi (i=1, 2, .. n) that corresponds to the probability of successfully delivering a message to the destination. As the paths are arranged according to their quality during the path construction phase, the first *k* paths out of the N available paths(refer to [4]) are selected to be used to transfer the gathered data.

2.7. Message Segmentation and FEC Codes Generation

Type	Reserved	Hop count
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Source Sequence Number		
Request Time		

Fig1.4:Structure of a RREQpacket

The data message(Fig 1.4 shows structure of a RREQ packet) is split up into *k* equal sized segments (*S0, S1, S2, ... Sk-1*), and over head part of M+1, error correction codes (C*0 C1, C2, C3, ... CM*) of same size as the data segment are added to the original message. The data segments and error correction codes are of the same size and should be multiple of 8. Correction codes are calculated as a function of the information bits to provide redundant information. We use an XOR-based coding algorithm. This algorithm does not require high computation power or high storage space.

3. Performnace Evaluation

Simulation environment consists of a field of 500m x 500m containing 300 sensor nodes randomly deployed. All nodes are identical with a radio transmission range set to 25m.

3.1. Network Size

The packets arrival rate is at 50 packets per sec, and change the number of nodes in the field from 50 to 300 nodes in step of 50 nodes each time

3.2. Energy Consumption

As the network size increases RELAX becomes more stable than other protocols. RELAX maintains low energy consumption even at higher traffic rates. Such results demonstrate that our protocol is stable in terms of energy consumption and is slightly affected by the increase in the traffic rate. When compared to directed diffusion, RELAX improves energy savings by 9% to 37%.

3.3. Delivery Ratio

As the network size gets large, there are more available nodes, and hence more routes to forward data, resulting in increasing the delivery ratio. Because multiple paths are used at the same time to transfer data packets. RELAX employs an error correction scheme which contributes in increasing the delivery ratio in the case of path failures by reconstructing the original message using the generated XOR-codes.

Delay RELAX protocol outperforms other protocols by having the shortest delay. This better performance is contributed by routing data across multiple paths and by the bulletin error correction scheme, which increases the resiliency of the protocol to path failures and increases the probability that an enough portion of the packet is received at the destination to recover the original data packet without incurring excessive delay through data retransmissions. *Node Lifetime* RELAX protocol outperforms other protocols and maintains long lifetime durations. This is because of the utilization of the relaxation effect of the batteries.

4. References

[1] K. Akkaya, M. Younis, "A Survey on Routing for Wireless Sensor Networks", Journal of Ad Hoc Networks, Vol. 3, Pages: 325-349, 2005.

[2] A. Martirosyan, A. Boukerche, R. W. N. Pazzi: A Taxonomy of Cluster- Based Routing Protocols for Wireless Sensor Networks. ISPAN 2008: 247-253

[3] A. Martirosyan, A. Boukerche, R. W. N. Pazzi: Energy-aware and quality of service-based routing in wireless sensor networks and vehicular ad hoc networks. Annales des Télécommunications 63(11-12): 669-681 (2008)

[4] J. Tsai, T. Moors, "A Review of Multipath Routing Protocols: From Wireless Ad Hoc to Mesh Networks", In Proc. of ACoRN Early Career Researcher Workshop on Wireless Multihop Networking, Jul. 17-18, 2006

[5] D. Ganesan, R. Govindan, S. Shenker, D. Estrin, "Highly-resilient, energy-efficient multipath routing in wireless sensor networks", ACM SIGMOBILE Mobile Comp. and Comm. Review, 5(4):11–25, 2001.