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Energy Efficient and Reliable Reverse Routing protocols in Wireless Sensor Network-A survey

G.Sridevi Devasena
Indian Maritime University Chennai Campus

ABSTRACT:
A survey of reliable routing techniques for Wireless Sensor Networks (WSN) is presented. WSN rapidly increases the applications areas, hence, characteristics of WSN require more effective methods for data forwarding and processing. Routing is simply the process of sending the data from the source to destination by discovering the route based on the availability of chain nodes i.e. multi-hop transmission, forms a connection between source and destination. Generally, “reactive routing” creates a route when a source node want to transmit a packet and it will respond to the changes very fast Since reliable reactive routing is mandate in order to achieve the desired energy efficient packet delivery rate and throughput. Here, several reliable reverse routing techniques for wireless sensor networks were compared and analyzed.

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I. INTRODUCTION:

A WSN consists of number of sensor nodes that are densely deployed in the network. These sensors are located to continuously monitor the physical or environmental conditions, such as temperature, sound, pressure etc. The main purpose of the sensor nodes is collecting the information and delivery throughout the network to a main location. Sensor nodes have the ability of sensing, computation and communication aspects. Sensor networks carried out two important operations such as data dissemination and data gathering. Data dissemination is the process of distributing data to the network. Data gathering is the process of bringing the data together at the sink node.The data passed from the source node to the destination node through the available route.

Generally, the routing protocol consumes high energy and leads to decreased network lifetime. To reduce energy use and increase network longevity, various routing techniques had been created. Routing protocols can be categorized based on node participation, mode of operation, clustering protocol, and network structure. Routing challenges include power consumption, node provisioning, scalability, connectivity, coverage, and security

Based on network structure routing protocols in WSNsare classified as location based routing protocols, flat routing protocols and hierarchical routing protocols Flat routing protocols are used to disseminate routing information to routers that are **interconnected** without any **organizational** or segmentation structure between them Hierarchical routing protocols are cluster based routing and specially designed for energy efficient wireless sensor networks. Location based routing protocols are used to determine the node location by using sensor nodes.

Recently, routing problems have become emergence of applications that require guarantees on a range of Quality of Service (QoS)parameters such as cost, delay, bandwidth, loss rate.

Routing Protocols

Ad-hoc On-Demanding Routing (**AODV**) Protocol has high routing overhead due to excessive broadcasting of routing discovery packets. In AODV protocol, a network-wide broadcast flood is required for each route discovery between a source node and a destination node. In addition, AODV is a single path routing protocol. **Dynamic Source Routing** (**DSR**) protocol is similar to the AODV and the routes are discovered on-demand. DSR has capability to discover multiple routes and it performs well in small networks. DSR includes the route information, a node list, in each packet delivery that leads to large packet size and more routing overheads, especially when routes are long this was considered as major limitation.

TORA (Temporally Ordered Routing Algorithm)is an on-demand routing protocol and this method was proposed based on Directed Acyclic Graphs (DAG). It endeavors to achieve a high degree of scalability using a non-hierarchical routing method.Loop-free multipath routing is achieved only by allowing packet flows from nodes with higher heights to nodes with lower heights. Thus TORA is good for dense networks. However, routing overheads is higher in TORA when compared to the both AODV and DSR. Ifthere is an increase in the number of nodes in the network, then the routing overhead also increases simultaneously.

II. RELIABLE ROUTING PROTOCOLS:

1. A Cooperative Selection Reactive Routing Protocol

A Co-operative Selection Reactive Routing Protocol (CSRRP) has presented to enhance the network performance. The global optimum path was achieved by finding shortest route by local optimum nodes from source to destination. In order to find the optimum route based on hop count and the number of flows, the RREQ is not dropped at the relay node. The cooperative selection decision is made at the destination node where, the optimum route among the best routes is selected. In RREP mechanism, a route was selected based on the cooperative selection mechanism among the reverse route entries available at the destination node. Applying this proposed mechanism in selecting the backward node leads to significant improvement as compared to selfish routing. In the CSRRP method the destination selects a lightly loaded backward route; this is why the throughput increases by 20.95% compared to AODV.

2. Reliable Routing in Large Scale WSN

WSN consists of a huge number of sensor nodes and a little sink nodes to collect information in the form of data from sensor nodes and these sensors and sink nodes form a large-scale wireless mesh network,here the packets are typically delivered between this nodes in a multi-hop manner. Reliable packet routing in wireless sensor networks is crucial, especially when network size is large. In order to improve the reliability of collecting data and controlling the command delivery in large wireless networks, Reliable Routing Protocol (RRP) had proposed. RRP intends to determine multiple bidirectional routes or path between a sensor node and a sink node. In order to guarantee a complete routing topology buildup sink node initiates the route construction with an imaginary node as the destination. The imaginary node does not exist in the sensor network physically. Imaginary node was assigned with different ID, from the ID of any real node. The imaginary node is the key to assure all sensor nodes can discover routes to the sink node. RRP achieves load balance by sending data packets via the route with lighter workload and hence optimized for lightweight routing.The figure shows the example of conventional route discovery. The sink node S initiates route discovery by broadcasting the RREQ packet. The RREQ packet can propagate to the destination node D via different routes, such as nodes S-1-2-D and S-3-D. The destination node D transmits the RREP packet back to node S. The node 4 cannot discover route to node S, because node 4 is out of transmission range of nodes 1, 2, 3 and S.

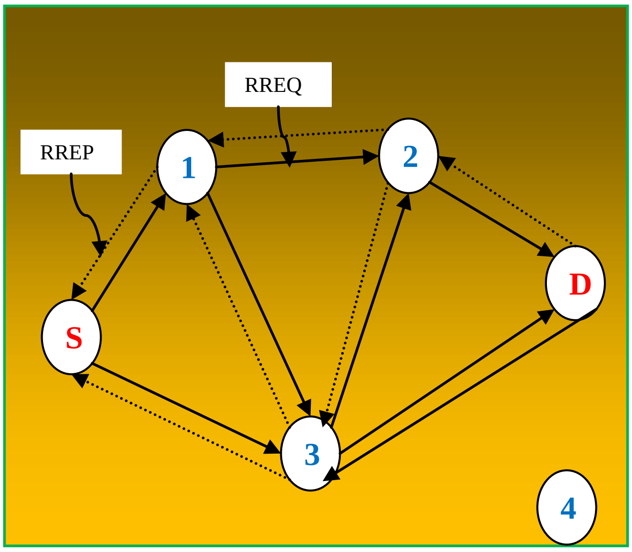

Fig.1 Example of conventional route discovery

3. Reliable Reactive Routing Enhancement (R3E)for Wireless Sensor Networks

R3E protocol had proposed to increase the resilience to link dynamics for WSNs/Industrial WSNs. This protocol had designed to improve the efficiency of the existing reactive routing protocols. This protocolalso provides reliable and energy-efficient packet delivery against unreliable wireless links by makes use of the local path diversity. Specifically, during the route discovery phase a biased back off scheme was introduced to find a robust guide path, that scheme can provide more cooperative forwarding opportunities. Hence, without utilizing the location, the data packets are greedily progressed towards the destination through nodes cooperation information along this guide path. This protocol achieves the advantages of opportunistic routing, shorter end-to-end delay, higher energy efficiency and high reliability. Without using location information, the effectively proposed cooperative forwarding scheme greedily forwards the data packet towards the destination along with the discovered robust virtual path. The downstream neighborhood information for each participated node was stored during cooperative forwarding process. The reliable route discovery module maintains the route information for each node available in the network.

4. Efficient Route Update and Maintenance for Reliable Routing

Rapid changes in channel conditions require accuracy while estimating the routing path performance and timely renewal of the routing information. It states that the routing path displays poor performance if it experiences a large number of packet drops. Once the routing path had declared to be poorly performing, it should be replaced with an alternative one.**To address** this **issue,** a combined global and local update **process has been** proposed for efficient route **updates** and maintenance. **Global processes update a** relatively long period of the routing path, **while** local **processes update a** shorter period **to check** for potential routing path **issues.**The combined global and local route update processes enhances the reliability of real-time data transmissions. With relatively long global update periods, the global update process evaluates routing paths and updates them as needed using PRR metric. With shorter local update periods, the local update process detects potential problems on the links along the routing paths between source-sink pairs.

5. Performance Guaranteed Routing Protocols for Asymmetric Sensor Networks

In this paper Asymmetric Sensor Networks (ASNs) for performance guaranteed routing protocols was proposed, where two end nodes don't have to use the same path to communicating with each other To achieve desired routing performance in ASNs, a general framework protocol called reverse path (RP) had been proposed. **It handles** asymmetric links and **provides** two efficient routing algorithms such as LayHet and EgyHet built on **the** RP to **meet** performance requirements.LayHet routing protocol is a performance guaranteed layer-based protocol that saves energy by minimizing the number of broadcasts and the probability of forwarding packets by embedding the shortest path information. EgyHet considers node's residual energythat gets updated by energy-upgraded version. This scheme achieves the desired delivery rate and outperforms in terms of average hops and packet replication overhead.

III. ENERGY EFFICIENT RELIABLE ROUTING:

1. Emerging Trends in Energy Efficient Routing Protocols

Energy Power Aware Routing (EPAR), Energy Power and Life Aware Routing (EPLAR),Efficient Power Aware Quality of Service (QEPAR) protocols, Loose-virtual clustering Routing protocol for Power Heterogeneous named as (LRPH), Energy entropy Multipath Routing optimized algorithm based on Genetic Algorithm (EMRGA) are mentioned according to their Specifications. EPAR comes under reactive routing protocol and it uses the Min-max formulation cost function approach to calculate the energy cost of the available link in network. This protocol selects the path based on minimum number of hops and available energy in that corresponding hops. EPLAR had proposed to overcome the disadvantages of EPAR. EPAR does not support frequent movement of nodes and no alternate path is determined in case of nodes in the original path depleted. EPLAR provide two advantages first it maintains link stability and other it provide security from black hole attack. In EMRGA algorithm, the minimum residual energy for the node is calculated for each path and the path with maximum or higher residual energy node is selected first and so on in descending order. The fitness of the path can be evaluated by combining the average energy and minimum node remaining power. QEPAR had proposed to enhance the network performance, which reduces end to end delay. This mechanism increases the network lifetime and minimizes the energy consumption with good packet delivery ratio. This protocol was provided with effective bandwidth (higher data rates) and energy consumption and also performs effectively in traffic loads.

2. Energy-Efficient and Reliable Routing

Hierarchical routing in sensor networks is considered to be an energy efficient and cluster based.Each cluster consists of one cluster head (CH) node, two Deputy CH (DCH) nodes, and some ordinary sensor nodes. The DCH nodes are used for mobility monitoring, collection of location information and this is also called as cluster management nodes. The concept of CH panel was introduced in order to minimize the re-clustering time and energy requirements. During initial stage of the protocol, the base station selects a set of probable CH nodes and forms the CH panel.If the current CH losses connectivity or its energy drained below its threshold level, the charge of headship was transferred to either one of the DCH or a node within the CH panel. Based on topology of the network, the data transmission from the CH node to the BS is carried out either directly or in multi-hop fashion. The total energy disbursement involved in a route due to communication is a function of two parameters, and those are as follows: the number of transmissions considering the source node and all intermediate nodes; the number of receptions considering the intermediate nodes and the destination node.

3. Energy Efficient Clustering Scheme

Clustering is an effective topology control strategy to increase network scalability and lifetime. It is one of the energy efficient schemes in sensor network. An Energy Efficient Clustering Scheme (EECS) was proposed to ensure the equal distribution of cluster head responsibility among the sensor nodes and better suits for the periodic data collecting applications. This scheme selects cluster head based on three metrics: current energy level of sensor nodes, distance to base station (sink node) and probabilistic approach. Based on the degree of the node, the cluster head was selected in the first round, hence the energy level is considered same for all the nodes in this round. In the forthcoming rounds, the sensor nodes are selected as cluster heads based on probabilistic function, distance from base station and average energy level. Therefore, EECS protocol minimizes the energy consumption by selecting the cluster heads based on metrics such as current energy level of sensor nodes, distance to base station and probabilistic approach.

4. Reliable Energy Aware Routing In Wireless Sensor Networks

A novel approach REAR (Reliable Energy Aware Routing) protocol for reliability in WSNs was proposed. REAR is a distributed, on-demand, reactive routing protocol proposed to provide a reliable transmission environment for data packet delivery in the network. Local node selection, path **reservation,** and **transmission delays for** path **requests have been** introduced to provide reliable transmission **status** to reduce retransmissions caused by unstable paths. To reduce the energy depletion of nodes on the path, an energy efficient path was determined. Every intermediate node on this path will reserve an amount of energy. REAR Backup path discovery was implemented to protect service path. Whenever the service path is broken, transmission of service path will be completely switched to disjoint backup path. The REAR scheme makes efficient use of the limited power and available memory resources of the sensor node. REAR tries to prevent the error rather than finding a solution after it occurs. Simulation resultsillustrate that, by using an energy reservation scheme, REAR outperforms traditional schemes by establishing an energy-sufficient path from the sink to the source with special path request flooding, and by distributing the traffic load more evenly in the network.

Table 1. Performance Evaluation of Energy efficient protocols

Energy Efficient Protocols	**Routing Protocol type**	**Performance Evaluation**			
		Hop Count	Estimated Transmission Count	Expected Transmission Time	Energy Consumption
Low Energy Adaptive Clustering Hierarchy (LEACH)	Hierarchical routing protocol	CH is responsible for transmission of data, so there is only one router isconsidered between member node and the BS. Hence, it is said to be single hop in nature. Hop Count: **Low**.	CH's are rotating to distribute energy loads to the member nodes. Even though CH are directly communicating with BS member nodes are not. Member nodes are more in number when compared to CH and it handling more load. ETX: **Low**	In order to evaluate ETT, end-to-end delay is considered. Bandwidth is a huge factor to determine the value of ETT. ETT: **Low**	Energy consumption is evenly distributed on the sensor nodes and hence the energy consumption is **High**.

Power-Efficient Gathering in Sensor Information System (PEGASIS)	Hierarchical routing protocol	The data get hopped from all members of the chain also for data aggregation, token based system is used. Hence hop count gets **higher** compared to other protocol.	PEGASIS follows chain-based approach for transmitting data. If any node dies in between, the chain was re-constructed again. Due to chain formation, transmission count has evaluated as **high** for this protocol.	ETX directly affects the metric ETT for this protocol. Hence it can be concluded that there is a network delay for a distant node on the chain as well. ETT: **High.**	Energy consumption is **very low** due tolower transmission distance and only single node is transmitting with the base station.
Threshold Sensitive Energy Efficient Sensor Network" (TEEN)	Hierarchical routing protocol	TEEN is a single hop mechanism and it is a derivative of LEACH protocol. Hop count: **Low**.	In the network, each CH in the cluster is not sending or transmitting the data all the time. So, the network throughput is very effective. ETX: **Very Low**	Since the data is not being transmitted continuously the contention in the network is very low, hence it's ETT is **very low**.	When sensor node is in idle status, then there is no energy consumption. Because of TEEN's threshold calculating capability CH not consuming energy continuously EC: **Low**

IV. REVERSE RELIABLE AND ENERGY EFFICIENT ROUTING:

1. Optimal Energy Reverse Reactive Routing Protocol

A new optimal energy conserving reverse reactive routing protocol (OERRRP) had proposed to calculate the shortest path in between any source-destination pair on demand. This OERRRP uses **Dijkstra's** optimal path routing algorithm and **operates over** the **available** bandwidth **as needed.** It has been recognized that OERRRP combines the improvement procedure of the routing protocols while reducing the limitations of the changed approaches which seeks to incorporate the metric "residual energy" in the process route selection, indeed the residual energy of mobile nodes were considered when making routing decisions. In a network, all nodes maintain a list of neighbors and this list contains stored information of cost vectors. During the communication if any kind of change in the topology including deletion of a host or a link must be communicated to the neighboring nodes.

2. Energy Reverse AODV Routing Protocol

An Energy Reverse Ad-hoc On-demand Distance Vector (ER-AODV) is a reactive routing protocol based on a policy, which combines two mechanisms used in the basic AODV protocol. Most of the on demand ad hoc routing protocols use single route reply along reverse path. The route reply could not arrive to the source node due to the occurrence of rapid changes in the topology. After a source node sends several route request messages, the node obtains a reply message, and this increases in power consumption. In order to improve the routing in term of energy conservation and to avoid huge consumption of power ER-AODV mechanism had proposed. Reverse AODV prevents a large number of retransmissions of route request messages.

V. CONCLUSION:

In WSN's Sensor nodes deals with energy optimization and quick route discovery problems. Different routing techniques had proposed to address these issues. Clustering is one of them and is used in hierarchical WSNs to reduce energy consumption. Several energy efficient protocols and reliable reverse routing techniques have discussed and their performance metrics is tabulated. The energy efficient and reliable reverse routing schemes are proposed to improve the performance metrics such as packet delivery, throughput and delay.

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