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On Opportunistic Routing in Wireless Sensor Networks

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Abstract— Opportunistic Routing (OR) is the latest strategy of routing in wireless sensor networks in which the nearer node to the target is selected for transferring the data. OR may immensely enhance the performance parameters like efficiency, throughput, and reliability by selecting best next hop in Opportunistic Protocol. In OR, a candidate set is chosen which serves the purpose of a potential group of nodes for packet forwarding. This paper presents the literature review of various opportunistic routing protocols. The tabular representation of various OR protocols on the basis of End-to-End delay, energy Efficiency, packet duplication and forwarding list selection is depicted in this paper. The comparative analysis of various opportunistic routing protocols has been given in this paper.

Keywords—Wireless Sensor Networks, Routing, Opportunistic Routing.

I. INTRODUCTION

A wireless sensor networks is a system of wireless devices that can monitor and record physical and environmental conditions like pressure, heat, position, humidity, direction & speed of wind etc. at diverse locations. With the increase in technology of WSN it became quite possible for sensors to capture not only static data but real time data as well from real time applications. The WSN technology has been improved to take account of sensor nodes as well as actuator nodes[1].

A sensor network consists of nodes which are portable and consists of transducers, microcomputers, transceivers and power source. The transducers are used to generate electrical signal based on the sensed input signal. The micro-computers are used to process and store the sensed output. The transceiver gets commands from the central computer and transmits information to base station. The required power supply is utilized from the power source of the sensor node.

The sensors are of diverse types like seismic, magnetic, radar, infrared, acoustic, and thermal. These sensors senses heat, humidity, vehicular movement, size of object, lighting conditions, the nearness or nonappearance of special sorts of items, speed, direction etc. The new applications of sensors are national security, fitness, homey and other business territories. We can additionally extend WSN applications in more classes like astronomy, chemical handling and calamity relief[2].

In order to exchange the data between the sensors nodes, routing protocols are used to find the optimal path between the sensor nodes. We can divide the routing protocols according to their network structure or their protocol action. As per structure the routing can be defined as Flat network routing, Hierarchical system routing, Area-based routing, and Opportunistic Routing. In flat network routing, all nodes are commonly allocated with similar roles and functionalities, and in hierarchical systems routing all nodes will assume distinctive roles while in area based routing the places of sensor nodes are used to route information in the network. The routing traditions may be also classified into three types i.e. proactive, reactive and hybrid. In proactive protocols all the feasible paths are figured in advance while in case of reactive the paths are computed on demand. The hybrid protocols utilize a blend of both proactive and reactive protocols[3]. There are different types of WSN routing protocols proposed by different researchers as shown in figure 1.

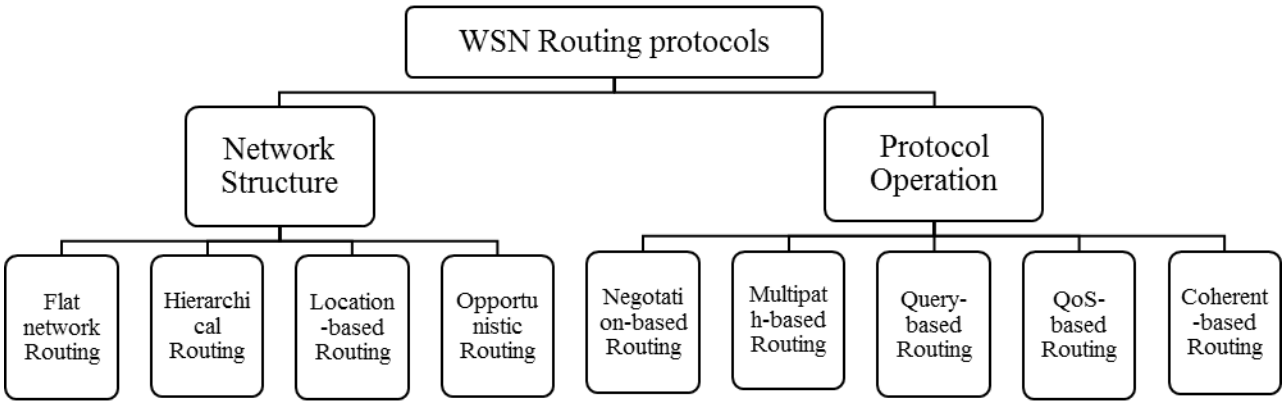

Figure 1. Protocols in WSN: a taxonomy [3]

The Opportunistic network can be defined as a sort of network where network nodes are scattered with no specific path from source to destination. The path between the source and destination may be highly unreliable and may often break or change. In order to make the communication possible, the intermediate nodes may take position of data during the failure and forwards the data back when the connection restores[4]. Opportunistic routing uses broadcast transmission to send packets through multiple relays and achieves higher throughput than the traditional one. The Biswas and Morris designed the first OR protocol in 2004 [5]. The primary idea of opportunistic routing is to select multiple forwarders, assign priority and transmits the data packets in such a way that if any forwarder fails the next priority forwarder handles accordingly. The sender transmits a group of data packets that is received by other nodes and receivers, if in case a data packet is missed by receiver during transmission the forwarder nearer to receiver will forward that packet to the target node and so on. This procedure continues till every one the packet are received by receiver[6].

In the figure 2 with a source node, destination node and many intermediate nodes in-between. The solid arrow represents optimal path i.e. opportunistic route, grey nodes are the relay nodes and dotted line represents the wireless link in-between nodes. The data packets reach the destination via the opportunistic route i.e. decided on the basis of link delivery probability (we can also choose the least energy consumption node or nearer node to the target) as shown in the Figure 2.

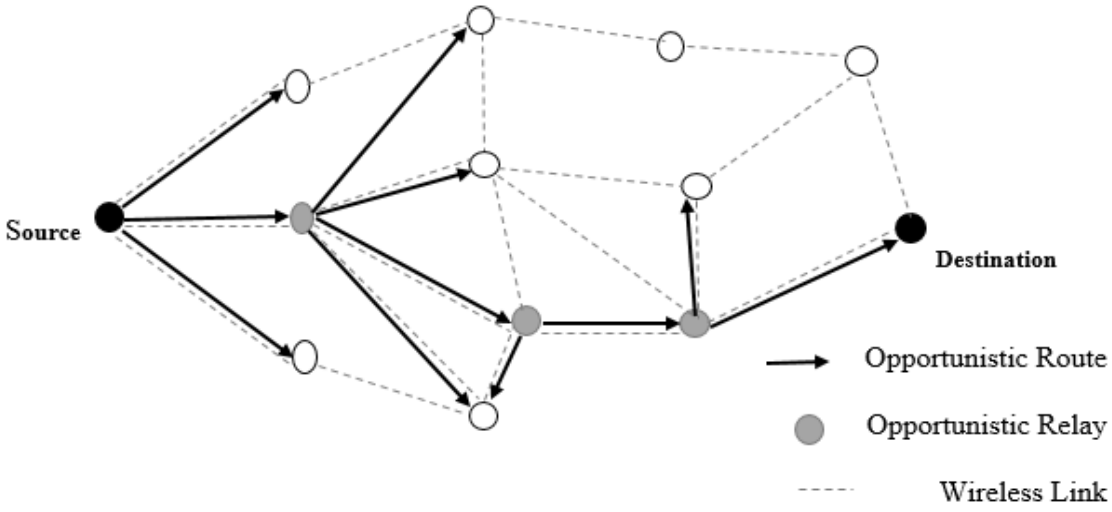

Figure 2. An example of data forwarding using Opportunistic Routing.

The traditional routing protocols will use a single node for data forwarding, while OR takes all the intermediate nodes for data forwarding therefore OR proves to be more efficient and reliable than the existing ones. In case of WSN

technologies, all the sensor nodes are supplied with limited amount of energy, the opportunistic routing may reduce the power consumption by minimizing delays and providing real time data delivery. In the remaining paper, existing OR based protocols have been discussed in section II. The section III presents tabular representation of various OR protocols with their critical analysis. The Conclusion of paper is given in section IV.

II. RELATED WORK

ExOR: Opportunistic Multi-Hop Routing for Wireless Networks [7]

ExOR is the first protocol which implements OR practically in wireless sensor networks. The data packets are sent into packets and the packets that have the similar destination address are assembled into a group with a unique group ID. The source describes the batch ID and forwarder list based on the ETX(Estimated transmission count) matrices using priority[7]: the shorter the separation from the target the greater is the priority. The nodes with higher priority are just fused in the forwarder and a nearby group outline kept up by every node in the forwarder list. The node appends the data parcel into the buffer parcel for the associated group. The transmission of packets is scheduled in such a way that just a single node sends the packet at a time.

Geographic Random Forwarding (GeRaF) for Ad Hoc and Sensor Networks: Multihop Performance[8]

The GeRaF that is Geographic Random Forwarding for Ad hoc and sensor networks. In this the author proposed the method GeRaF based on geographic routing. In wireless network, the relay node is unknown and is decided after data transmission by using telecasting nature of the wireless networks. As the network topology keeps on changing the sender node is unaware of which neighboring nodes acts as relay nodes. The sender node simply broadcasts the data packets along its own particular and target area. All the neighboring nodes will listen the data packet and prioritize themselves according to their distance from the relay node. The transmitted packet is then transferred to a broadcasting address which provides a geographic routing by using the transmitter and final destination location.

Optimal Forwarder List Selection in Opportunistic Routing[9]

In case of optimal forwarder list selection in opportunistic routing the author suggests MTS algorithm for forwarding list selection therefore the expected transmission rate gets minimized using ideal ACK condition. To compute the optimal forward list, we use ExOR instead of ETX. The MTS based ExOR is better as compared to ETX based ExOR except in certain conditions.

Spectrum Aware Opportunistic Routing in Cognitive Radio Networks[10]

Shin-Chun Lin and K C Chen proposes SAOR in which they use optimal link transmission (OLT) as a cost matrix for node priority of the forwarded list. The OLT is considered in the delay aspect. The Optimal path matrices and node metrics are the other two matrices that further explains the number of hops and delay status with their respective paths to the destination.

Energy-Efficient Opportunistic Routing in Wireless Sensor Networks[11]

EEOR suggests the method to choose the forwarding list using minimum energy depletion cost matrices during broadcasting in WSN. It ascertains the assessed cost for every hub to exchange the data and selects forwarding list. The main idea of selecting forwarding list is that the estimated cost of newly added node should be less than the previous forwarding list so that the estimated cost of new forwarding list will be minimum. The EEOR is fast than ExOR in both transmission and receiving of data.

Multi-Channel Opportunistic Routing in Multi-Hop Wireless Networks[12]**.**

The MCExOR is a multi-channel convention and expands ExOR which uses several radio frequency (RF) channels in multi-hop networks. The essential purpose behind the low limit of multi-hop systems are interference combined with huge number of transmission in end-end delivery. It lowers the transmission number by skipping nodes in a forwarding path opportunistically. It requires single RF transceiver for each device while selecting RF channel independently of routing function.

Optimized Multipath Network Coding in lossy wireless networks [13]

The OMNC, proposed by X Zhang and B Li. The algorithm uses different paths to send data packets to the receiver's end, to transfer data between neighboring nodes it makes use of broadcast MAC. The transmission and coding rate is shared to transmitter via dispersed optimization algorithm that boosts the coding during evading jamming.

Simple Opportunistic Adaptive Routing protocol (SOAR)[14]

The SOAR is suggested by Eric Rozner, J Seshadri. It accomplishes great outcomes than ExOR by successfully using the accompanying parts: adaptive transmitting path to dodge copy transmissions, precedence based clocks, neighbouring loss restoration method and adaptive rate manage. SOAR successfully underpins numerous simultaneous streams by moving forward both good-put and fairness.

ROMER : Resilient Opportunistic Mesh Routing for Wireless Mesh Networks[15]**.**

ROMER was proposed by Yuan et al which is intended to accomplish the objectives of decrease routing overhaul overhead flexibility against connection's termination and enhancing output. This objective is accomplished by

lessening routing refreshes through building runtime work on the fly, enhancing output by abusing quick frequency varieties and haphazard sending by abusing diverse information rate and damage amount.

III. COMPERATIVE ANALYSIS

WSN routing is an extremely significant job and has pulled in consideration of researchers during current years. Routing in WSN have different challenges than traditional networks. The comparative analysis of above discussed protocols based on some of the important parameters like forwarding list selection, packet duplication, end to end delay, and energy efficiency are described in table 1. The analysis is carried out after a thorough study of the protocols. We found that forwarding list selection is either end to end (selected from source to destination) or hop to hop (selected from node to node). We also found that there is packet duplication and end to end delay in few protocols as mentioned in the table.

Table 1. Comparison and classification of various OR protocols

Protocol	Forwarding List Selection	Packet Duplication	End-to-End Delay	Energy Efficiency	Protocol Designed For Which network?
ExOR[7]	End to End	Y	N	Medium	Ad-hoc Sensor Network. Wireless Sensor Network
GeRaF[8]	Hop by Hop	Y	N	Low	
MTS[9]	End to End	N	N	Low	Wireless Sensor Network Short haul Multi hop WSN
SAOR[10]	Hop by Hop	N	Y	Medium	Cognitive Radio Network Wireless Sensor Network Adhoc Sensor Network
EEOR[11]	End to End	N	Y	High	
McExOr[12]	End to End	N	N	High	Unicast and lossy Networks
OMNC[13]	End to End	N	N	High	
SOAR[14]	End to End	Y	N	High	Adhoc Sensor Networks and WSN
ROMER[15]	Hop by Hop	Y	N	High	

IV. CONCLUSION

The Routing is the prime functionality of networking that is used to deliver packets efficiently. Over the year's various protocols have been developed to achieve such functionalities that can deliver packets in a much robust manner. In this paper we have reviewed some of the most important protocols and have presented a comparative analysis of mentioned protocols. During the study we found that Opportunistic routing protocols have not been explored much. Therefore, a new opportunistic protocol will be proposed that would suffice the energy efficiency constrains present in existing protocols.

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