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Survey on Energy-Efficient Wireless Sensor Networks

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***Abstract* – Wireless network (WN) is a network which consists of group of dispersed sensors. In Sensor network along with traffic and conjunction control, battery power is also very important issue in Wireless nw for longer survival of network. There is not any centralized power controller for mobile node in Wireless network. By any means if the node has lost their energy then it is not practical to replace all battery over the network. One possible approach is to utilized battery power of node efficiently. The meaning of efficient use of battery power is to check battery power of node before participating in route discovery in order to reduce redundancy over the network. In this paper it seems to be that the routing protocols and the energy conservation methods to try and conserve the battery energy of the sink node from depleting. The sensor nodes deplete their energy and consequently their lifetimes, mainly those near the sink as they consume more battery because they have to deliver their own and other nodes' data.**

***Keywords* – Wireless Network, Sensor Network, Routing Protocol, AODV, Energy Efficient Routing, Sensor Node.**

I. INTRODUCTION

In recent years, wireless multi-hop networks such as ad hoc networks, sensor networks and vehicular networks have been very important subject for research. A Wireless Sensor network is a collection of wireless mobile terminals that is able to dynamically form a temporary network without any aid from fixed infrastructure or centralized administration. In recent years, Wireless Sensor network is continuing to attract the attention for their potential use in several fields. In order to ensure effective operation as the total number of nodes in the Wireless Sensor network becomes very large, the overhead of the employed routing algorithms should be low and independent of the total number of nodes in Wireless network. Mobility, node density and the absence of any fixed infrastructure make Wireless network very attractive for mobility and rescue operations and time-critical applications. Because of the nodes are free to move randomly, the topology of network may change rapidly and may be unpredictable, which makes the traditional protocol not suitable for Wireless Sensor network. The Mobility influences ongoing transmissions, since a mobile node that receives and forwards packets may move out of range. The movement pattern of Wireless network nodes is characterized by mobility models and each routing protocols exhibits specific characteristics of these models.

In order to find the most adaptive and efficient routing protocol for dynamic Wireless network topologies, the behaviour of routing protocols needs to be analyzed at varying node speeds, number of traffic nodes, network size, as well as node density. The desired challenges in Wireless Sensor network includes: unreliability of wireless links between nodes, dynamic topologies, Lacking of secure boundaries, Threats from Compromised nodes inside the Network Lacking of centralized management facility, restricted power supply and scalability [1]. Security issues are also there like attacks, session hijacking, Eavesdropping, Jamming, Denial of Service etc. [2].

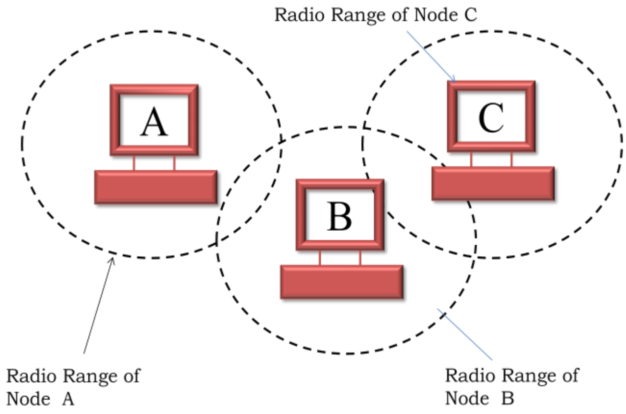

Fig.1. Radio Range of Sensor Node

The above discussion leads us to believe that it is first understand and evaluate the performance of routing protocols in different mobility scenarios before selecting a protocol for a particular scenario. Most previous studies with routing protocols select the Random Waypoint mobility model for simulations. In this paper, we presented the results for various proactive, hybrid and reactive protocols like Ad Hoc On Demand Vector (AODV), Dynamic Source Routing (DSR), Dynamic Wireless Sensor network On Demand (DYMO), Optimized Link State Routing (OLSR) and Zone Routing Protocol (ZRP).

II. ROUTING PROTOCOLS: A BRIEF OVERVIEW

Sensor Network routing protocols are IP based and may use unicast, multicast or hybrid approaches and should allow for interaction with standard wired IP services rather than being regarded as a completely separate entity. Figure 2 shows the categorization of different routing protocols of sensor Network with brief description in further section.

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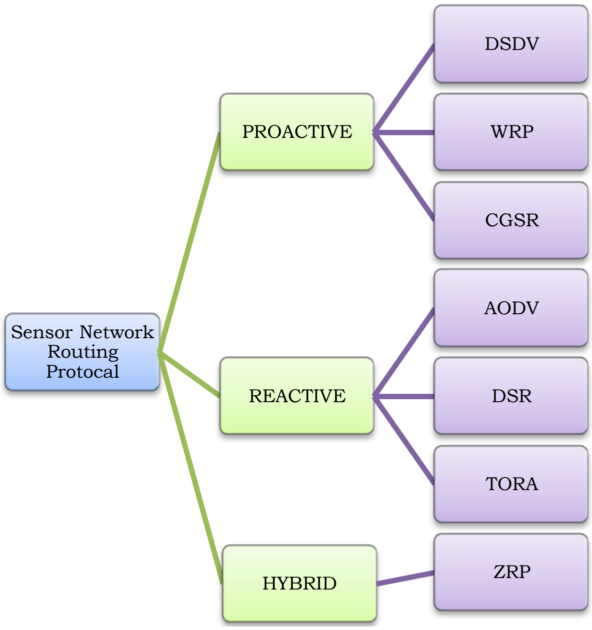

Fig.2. Hierarchy of Routing Protocol

Reactive Routing Protocols:- In reactive (also known as Demand based) routing protocols, a route is discovered only when it needed. Nodes only maintain routes to active destinations. The communication overhead is reduced at the expense of delay due to route search. These protocols are significant for the Ad hoc environment since battery power is conserved both by not sending the advertisements and by not receiving [3]. All nodes maintain the discovered routes in their routing tables. However, only valid routes are kept and old routes are deleted after an active route timeout. A serious issue for Wireless Sensor network arises when link failures occur due to high node mobility; at the same time new links may also be established between previously distant nodes. This significantly increases the network broadcast traffic with rapid link make/break effect of intermediate nodes.

Adhoc on Demand Distance Vector (AODV): Ad hoc on Demand Distance Vector is a reactive protocol implies that it only requests a route when it needs one and does not require that the mobile nodes maintains routes to destinations that are not communicating. AODV guarantees loop free routes by using sequence numbers that indicate how new, or fresh, a route is. AODV requires each node to maintain a routing table containing one route entry for each destination that the node is communicating with. Each route entry keeps track of certain fields such as Destination IP Address, Destination sequence number, Next Hop, Hop Count. To find a path to a destination a node using AODV broadcasts a route request (RREQ) packet. The RREQ contains the node's IP address, current sequence number, broadcast ID and most recent sequence number for the destination known to the source node. The destination node on receipt of RREQ, unicasts a route reply (RREP) packet along the reverse path established at the intermediate nodes during the route discovery process. In case of a link failure, a route error (RERR) packet is sent to the source and destination nodes. By the use of sequence numbers, the source nodes are always able to find new valid routes [5][6].

Dynamic Source Routing (DSR): Like AODV, DSR establishes a route to the destination when a source node requests one. DSR uses the source routing strategy. It uses source routing which means that the source must know the complete hop sequence to destination. Each node maintains a route cache, where all routes it knows are stored. The route discovery process is initiated only if the desired route cannot be found in the route cache. To limit the number of route requests propagated, a node processes the route request message only if it has not already received the message and its address is not present in the route record of the message.DSR uses source routing, i.e. the source determines the complete sequence of hops that each packet should traverse. This requires that the sequence of hops is included in each packet's header. A negative consequence of this is the routing overhead every packet has to carry. However, one big advantage is that intermediate nodes can learn routes from the source routes in the packets they receive. Since finding a route is generally a costly operation in terms of time, bandwidth and energy, this is a strong argument for using source routing. Another advantage of source routing is that it avoids the need for up-to-date routing information in the intermediate is included in the packets. Finally, it avoids routing loops easily because the complete route is determined by a single node instead of making the decision hop-by-hop [7].

Dynamic MANET on Demand (DYMO): DYMO routing protocol enables reactive, multi-hop unicast routing between participating DYMO routers. The basic operations of the DYMO protocol are route discovery and route maintenance. During route discovery, the originator's DYMO router initiates dissemination of a RREQ throughput the network to find a route to the target's DYMO router. During this hop by hop dissemination process, each intermediate DYMO router receives the RREQ, it responds with a RREP sent hop-by-hop toward the originator. When the originator's DYMO router receives the RREP, the routes can be established between the originating DYMO router and the target DYMO router in both directions [8]. In order to react to changes in the network topology nodes maintains their routes and monitors their links. When a data packet is received for a route or link that is no longer available for the source of the packet is notified. A Route Error (RERR) is sent to the packet source to indicate that the current route is broken. Once the source receives the RERR, it can perform route discovery if it still has packets to deliver [9].

Proactive Routing Protocols:-In proactive schemes, also known as table driven approaches, every node continuously maintains the complete routing information of the network. When a node needs to forward a packet, the root is readily available; thus there is no delay in searching for a root. However for a highly dynamic topology, the proactive schemes spend a significant

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amount of scarce wireless resources in keeping the complete routing information correct [10]. However, when frequency of link breakage is high, the proactive routing protocols need a higher rate routing table updates, which lower the network performance.

Optimized Link state Routing: OLSR employs three mechanisms for routing; (1) periodic HELLO messages for neighbour sensing. (2) Control packet flooding using Multi- Point Relay (MPR) and (3) path selection using shortest path first algorithm. Each node, by using its two-hop neighbours is accessible. Nodes then rebroadcast only those messages that are received from nodes who selected it as an MPR. This mechanism efficiently reduces the broadcast control overhead and thus each node has a partial topology graph of the whole network. Each node selected as an MPR, transmits Topology Control (TC) messages to broadcast its presence to its MPR selector set. TC messages contain originating nodes address and its MPR selector set. Once routes are available to source node, it selects the optimal path using shortest path first algorithm [11].

Hybrid Routing Protocols Hybrid routing is the third category of routing scheme, in which proactive and reactive, both approaches are combined. An example of such a protocol is Zone Routing Protocol (ZRP).

Zone Routing Protocol (ZRP): The Zone Routing Protocol or ZRP combines the advantages of both pro-active and re-active protocols into a hybrid scheme, taking advantage of pro-active discovery within a node's local neighbourhood and using a reactive protocol for communication between these neighbourhoods. Both a purely pro-active or purely reactive approach to implement a routing protocol for a MANET has their disadvantages. ZRP is not so much a distinct protocol as it provides a framework for other protocols [12]. The separation of nodes local neighborhood from the global topology of the entire network allows for applying different approaches. These local neighborhood are called are called zones. Each node may be within multiple overlapping zones and each zone may be of a different size. Comparative analysis of different routing protocol of each class whether it is proactive, Reactive or hybrid is categories with advantage and disadvantage in Table 1.

Table 1: Advantage and Disadvantage of Different Reactive Protocol

Protocol	Advantage	Disadvantage
DSR	Multiple routes, Promiscuous overhearing	Scalability problems due to source routing and flooding, Large delays[16]
AODV	Adaptable to highly, dynamic topologies	Scalability problems, Large delays, Overhead due to Hello messages
AODV-BR	Better throughput performance than AODV	Not efficient in heavily loaded frequently changing networks.
AOMDV	Reduces routing overhead, low intermodal coordination overhead.	Do no scale well in moderate to sparse networks due to equal length multiple paths.[18]
AODV-ABR	More adaptive to variation of network topology, smaller control overhead[18,19]	Lower probability of finding an alternate route
TORA	TORA provides the supports of link status sensing and neighbor delivery, reliable, in-order control packet delivery and security authentication.[17,18]	It depends on synchronized clocks among nodes in the ad hoc network & dependence over intermediate lower layers for certain functionality presumes with higher overhead[17,20].

III. RELATED WORK

Chu-Fu Wang [1] work on the network life time. The depleting speeds of battery energy of sensor nodes will significantly affect the network lifetime of a WSN. They have proposed an energy-aware sink relocation method (EASR), which adopts the energy-aware routing MCP as the underlying routing method for message relaying. Davut Incebacak [2] has investigated various data compression strategies to maximize the lifetime of WSNs employing contextual privacy measures through a novel mathematical programming framework. Here the author has achieved the better energy savings when compared to static compression/decompression of data in which the data is always compressed independently of the power transmission strategy In [3] author has proposed a scheme that satisfies a given 'target' lifetime. Energy consumption depends on traffic volume, the target lifetime cannot be guaranteed through energy-efficient routing alone. The author took an approach that jointly optimizes the sensing rate and route selection. This scheme is based on a simple Linear Programming (LP) model. The simulation results indicate that the proposed scheme achieves near-optimality in various network configurations.

Table 2: Survey of Energy Efficient Sensor Network

Paper Title	Approached used/Suggestion	Merits	Demerit	Published Year
A network lifetime enhancement method for sink relocation and its analysis in wireless sensor networks	Energy-aware sink relocation method (EASR), which adopts the energy-aware routing MCP as the underlying routing method for message relaying	Sink node provide better node supplement	Enable to avoid unauthorized user nodes	**IEEE 2014**
Optimal Data Compression For Lifetime Maximization In Wireless Sensor Networks Operating In Stealth Mode	Data compression strategies to maximize the lifetime of wsns employing contextual privacy measures through a novel mathematical programming framework	Better energy savings when compared to static compression/decompression of data	Compressed Independently Of The Power Transmission Strategy	**Elsevier 2015**
Satisfying The Target Network Lifetime In Wireless Sensor Networks	Energy consumption depends on traffic volume, the target lifetime cannot be guaranteed through energy-efficient routing alone. The author took an approach that jointly optimizes the sensing rate and route selection.	Proposed scheme achieves near-optimality in various network configurations	Not work over sensing rate and route selection	**IEEE 2014**
Enhancement Of Wireless Sensor Network Lifetime By Deploying Heterogeneous Nodes	Work over energy imbalance in WSN occurs due to relaying of data from different parts of the network towards sink	Energy imbalance in WSN occurs due to relaying of data from different parts of the network towards sink	Not desirable to deploy relay nodes in addition to sensor nodes to manage such imbalance	**IEEE 2014**
Energy Efficient Routing in Wireless Networks in the Presence of Jamming	full target coverage problems malicious jammers used for sensing data and transmit it to the base station through multi-hop communication as well as sensors used only for communication purposes	Duty scheduling of sensor activities in wireless sensor networks to maximize the lifetime	Enable to avoid jammer in case of shortest path	**IEEE 2015**

In [4] author has first investigated the problem for enhancing network lifetime using homogeneous sensor nodes. The author has observe that, it is revealed that energy imbalance in WSN occurs due to relaying of data from different parts of the network towards sink. So for improved energy balance instead of using only sensor nodes it is desirable to deploy relay nodes in addition to sensor nodes to manage such imbalance. In [5] author has consider the duty scheduling of sensor activities in wireless sensor networks to maximize the lifetime. They address full target coverage problems malicious jammers used for sensing data and transmit it to the base station through multi-hop communication as well as sensors used only for communication purposes. Related work is also briefly explained in table 2.

IV. CONCLUSION

The large number of work has done in order to find the path when node will discharge in the network. Due to this break down the overall performance of network will also decrease with respect to complexity of routing protocol. The objective of this dissertation is to develop a methodology in order to enhance the network survive as long as possible. Sink relocation protocol minimizes the conjunction and overhead of route discovery by relocating lower energy node which lead to degrade overall performance of network. By any means if the node has lost their energy then it is not practical to replace all battery over the network. One possible approach is to utilized battery power of node efficiently.

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