Survey on Routing Protocol in Wireless Sensor Network

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Abstract— **The Wireless Sensor Network (WSN) is a wireless network consisting of ten to thousand small nodes with sensing, computing and wireless communication capabilities. WSN are generally used to monitor activities and report events, such as fire, overheating etc. in a specific area or environment. It routs data back to the Base Station (BS). Data transmission is usually a multi-hop from node to node towards the BS. Sensor nodes are limited in power, computational and communication bandwidth. Primary goal of researchers is to find the energy efficient routing protocol. This study highlights the different routing protocol with advantages and limitations.**

Keyword- Wireless sensor Network, Protocols, Multi-hop, Energy Efficient, Network lifetime, Fault tolerant, Ad hoc Networks.

I. INTRODUCTION

Wireless sensor networks is widely considered as one of the most important technologies. WSN has provided a small and low cost sensor node with the capability of sensing various types of environmental phenomena and wireless communication [5,14]. In most WSN application, sensor nodes are deployed in ad hoc fashion without engineered. Once deployed sensor nodes are expected to autonomously organize themselves into wireless medium. It consists of protocols and algorithm with self organizing capabilities. The main goal of WSN is detect the occurrences of events, classify a detected object and track an object.

Design issues of sensor network are fault tolerance, scalability, production cost, operating environment, power consumption, data aggregations, Quality of Service [17]. Routing protocols are province for finding and keeping the routes in the network. Moreover, the rightness of a particular routing protocol mainly relies on the potentialities of the nodes and on the application prerequisites.

Researchers have been designed a number of different routing protocols. This paper discus about routing protocols for sensor networks. The three main classes analyze in this paper are flat, hierarchical and location based routing protocols. Each protocol is depicted and covered under the appropriate category.

The rest of the paper is structured as follows. Section 2 exhibits routing techniques in WSN. Section 3, poses the most common classification schemes for routing protocols. Section 4 highlights the advantages and performance issues of hierarchical routing and finally, Section 5 contains conclusion.

II. ROUTING TECHNIQUES IN WSN

The growing interest in WSN and the emergence of new architectural technique is the reason for studying of routing protocols. Routing protocols for wired networks and ad-hoc networks are not applicable to wireless sensor networks. It should be energy conserving, scalable, robust, fault tolerant and self organizing. Based on the underlying network structure routing techniques are classified into three categories: flat, hierarchical and location based routing. Based on the protocol operation it can be classified into Negotiation based, Multi-path, Query based, QoS based and Coherent based routing. Routing Techniques classification is shown in the following figure1.1.
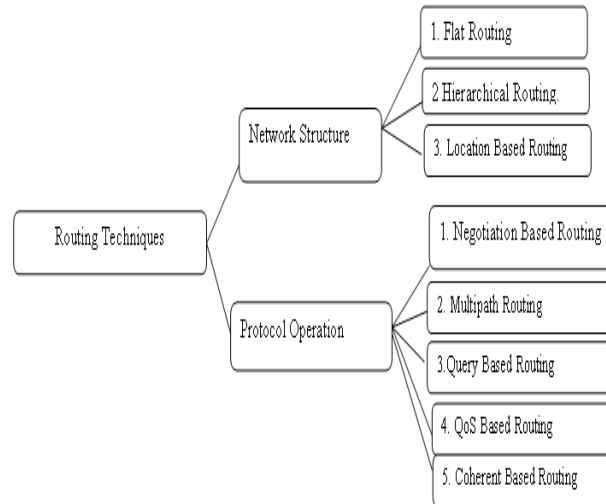
Fig. 1. Classification on Routing Techniques

A. *Flat Routing* :

In Flat routing protocol all node play same role. Each node distributes data to other reachable node within the sensor cloud. Link utilization differs greatly between different routing algorithms [1]. Flooding [6], Gossiping [7] and SPIN[11] are example of flat routing protocols. In Flooding, node A sends data to all neighbors. Neighbors of A send data to their entire neighbor till all nodes received the data. In Gossiping, data is only forwarded to one randomly selected neighbor. It saves energy compare to flooding. Sensor Protocols for Information via Negotiation(SPIN) before transmitting data, nodes negotiate with each other so that it will overcome collapse and overlap of nodes. That is only useful information will be transferred. Observed data must be described by meta-data.

B. *Hierarchical Routing*:

Hierarchical routing saves total energy consumption of WSN. In this routing cluster is created and as head node is assigned to each cluster. The head nodes are the leaders of their groups having responsibilities to collect and aggregate data from their respective clusters and forwarded the aggregated data to the base station. This aggregation of data will greatly reduce the energy consumption in the network that will lead to increase the life time of sensor network.

The main idea of developing cluster-based routing protocols is to reduce the network traffic towards the sink [8,21]. It has been demonstrated that cluster-based protocols exhibit better energy consumption and performance when compared to flat network topologies.

C. *Location Based Routing*

In WSN some real time application needs to know about location of node before communication. Geographic routing also called directional, geometric, position-based or Location based routing protocol find the geographical position of node and then transmit the packet.

III. CLASSIFICATION OF ROUTING PROTOCOL

Many different routing protocols have been proposed for WSN. These protocols can be classified based on different parameter like routing algorithm, network structure and protocol operation.

The following table describes the routing protocol with their main contribution and limitation

TABLE 1.
Various Routing Protocol with main contribution

AUTHOR & YEAR	PROTOCOLS	MAIN CONTRIBUTION
Singh et al 1998	**MBCR**:Minimum Battery Cost Routing	It considers only the remaining power of nodes to prolong network lifetime by selecting from all available paths the one path with maximum remaining power.[1]

Intanagonwiwat, C et al., 2000	**Direct Diffusion:** A Scalable and Robust Communication Paradigm for Sensor Networks	This is a data centric approach (i.e) communication based on named data not named nodes. It requires only localized interaction between nodes. There are four main features are Interests, Gradients, Data and Reinforcement.[2]
Heinzelman,2000	**LEACH:** Low Energy Adaptive Clustering Hierarchy	Sensor nodes dynamically form cluster. When a cluster is formed, a sensor node in the cluster randomly selects the cluster head. All cluster head transfer the collected information to the sink node[3]
Toh,2001	**MMBCR:** Min-Max Battery routing	This protocol selects the path in which the minimum remaining power of nodes in this path greater than maximum remaining power in other paths.[1]
A.Manjeshwar and D.P Agrawal,2001	**TEEN:** Threshold sensitive Energy Efficient sensor Network	Time critical data reaches the user almost instantaneously. The soft threshold can be varied, depending on the criticality of the sensed attribute and target application. It will also enhance the efficiency of wireless sensor networks[4]
J. Kulik et al ,2002	**SPIN:** Sensor Protocols for Information via Negotiation	SPIN (Sensor Protocols for Information via Negotiation), that efficiently broadcast information among nodes. These Nodes which use the Spin protocol name their data called meta-data which will eliminate the redundant data throughout network[6]
Lindsey and Raghavendra 2002	**PEGASIS:** Power Efficient Gathering In Sensor Information System	It is an enhancement over LEACH and it is near optimal chain based protocol. It will focus the extend the life time of network by communicate with its closest neighbor. It will avoid cluster formation and use only one node to communicate with base station instead of with multiple nodes.[9]
O. Younis, and S. Fahmy 2004	**HEED: H**ybrid **E**nergy **E**fficient **D**istributed	In this protocol cluster head formation is based on node proximity to its neighbor and its residual energy[12]
Hassanein &leo, 2006	**REAR:**Reliable Energy Aware Routing	Reliability of packet delivery is high and also energy aware. It will uses three type of nodes Sink, Intermediate node, and target Sources. The four parts of REAR are: Service Path

		Discovery(SPD),Backup Path Discovery (BPD), Reliable Transmission, Reserved Energy Release.[13]
Sangho Yi,2007	**PEACH:P**ower **E**fficient and **A**daptive **C**lustering **H**ierarchy	Cluster formation is performed by using overhearing characteristic of wireless communication to support adaptive multilevel clustering and avoid additional overheads.[15]
Jong-Myoung Kim et al,2008	**CHEF**: Cluster Head Election mechanism using Fuzzy logic in Wireless Sensor Networks	It applies centralized clustering algorithm-all clustering decision are made at base station. Node concentration, residual energy in each node and node centrality are fuzzy descriptors. BS elects the cluster head based on the 27 fuzzy if-then rules.[16]
Dilip Kumar, et al 2009	**EEHC:E**nergy **E**fficient **H**eterogeneous **C**lustered scheme for Wireless Sensor Network	The energy efficiency and ease deployment make EEHC is robust protocol[18]
A. Manjeshwar and D. P. Agrawal, 2009	**APTEEN:** Adaptive Periodic Threshold-sensitive Energy Efficient sensor Network protocol	In this protocol once Cluster Heads are decided, in each round CH first broadcast the Attributes(A), Threshold(T), Schedule, and Count Time. It combine both reactive and proactive polices and provide periodic data collection as well as event detection. [10]
Ehsan Ahvar et al,2011	**FEAR**: A Fuzzy-Based Energy-Aware Routing Protocol	It contains three steps: Neighbor Discovery, Forward data, Energy update.[19]
Hoda Taheri et al 2012	**ECPF**:An energy-aware distributed clustering protocol in wireless sensor networks using fuzzy logic	It contains three techniques: non-probabilistic cluster head(CH) election, fuzzy logic and on-demand clustering.[21]
Ching-Wen Chen and Chann-chi Weng,2012	**MTPCR:**Minimum Transmission Power Consumption Routing Protocol	This protocol finds a path with high transmission bandwidth by considering the distance between two nodes and channel contention in MAC layer[22]
Kai Lin, et al 2012	**EBMA:**Energy Balancing Cluster on	Based on the cellular topology cluster is formed and energy is balanced in inter and intra cluster.

	Mobile Agent.	[23]	
Lei Shi et al,2012	**DDRP:** An efficient data-driven routing protocol for wireless sensor networks with mobile sinks	It will reduce the topology overhead and extend the life time of WSN.[24]	
Eduardo Cañete et al, 2012	**HERO:** A hierarchical, efficient and reliable routing protocol for wireless sensor and actor networks	It will form the cluster in efficient way using meta data It not only allows developers to send data from sensor node to CH and vice versa but also allow them to define the desired reliability level in quantitative way.[25]	

TABLE.2
Various Routing Protocol and their Applications

Routing Protocol	Routing Techniques	Power Consumption	Application Type
SPIN	Flat Routing	Limited	Habit Monitoring
Directed diffusion	Flat Routing	Limited	Environment Monitoring
Rumor routing	Flat Routing	Low	Habit/Environmental monitoring
GBR	Flat routing	Low	Health monitoring
LEACH	Hierarchical routing	High	Health monitoring
TEEN &APTEEN	Hierarchical Routing	High	Home / Office
PEGASIS	Hierarchical routing	Maximum	Health monitoring
PEACH	Hierarchical routing	Limited	Health monitoring
HEED	Hierarchical routing	Low	Health monitoring
SPAN	Hierarchical routing, Location based routing	Limited	Military/ Civilian
GEAR	Hierarchical routing, Location based routing	Limited	Home / Office
GAF	Location based routing	Limited	Military monitoring
SPEED	Location based routing	Low	Health monitoring

IV. ANALYSIS

Flat routing is simple protocol but it suffers large amount of control packet overhead and lack of scalability. In recent year, researches are moved to Hierarchical routing. Compared with all routing protocols in WSN, Hierarchical routing protocols has many advantages like more scalability, consume less energy and more robustness [20]. This section summarizes the advantages of hierarchical routing..

1) More Scalability

Scalability refers to the performance of communicating system won't be degraded when number of nodes will increases. In WSN, there may be thousand of nodes. It can be achieved by localize the interaction among the communicating nodes, which can be done through hierarchical routing. Compare to flat routing it can be easily manageable.

2) Less Energy

In hierarchical routing Cluster head performs data aggregation and data transmission. This will lead save great deal of energy compare to flat and location based routing. In addition to that clustering with inter and intra cluster communication reduces the node to communicate with node present in long distance. This will also help to consume less amount of energy.

3) More Robustness

The topology of a WSN may change due to alternative state of sensor node from sleep node to active node. Hierarchal routing is highly suitable for topology control and network management. It is work well in large-scale scenario compared to flat routing which is always reactive or proactive.

Moreover Hierarchical routing is reservation-based, collisions avoided, Fair channel allocation, Reduced duty cycle due to periodic sleeping of node, simple but not a optimal routing and energy dissipation is uniform. It has two main drawbacks. First overhead of cluster head formation throughout the network and second it require global and local synchronization. The following table illustrates the comparison between flat and hierarchical routing.

TABLE
Comparison of Flat and Hierarchical routing

	Flat routing	Hierarchical routing
Scalability	Low	High
Fairness	High	High
Protocol complexity	Simple	Complex
Control packet overhead	High	Low
by flooding	Reservation based	Contention Based
Scheduling		

V. CONCLUSION

WSN is most emerging ubiquitous computing technology which can be employed in wide spectrum of application in both civilian and military scenarios [5]. Wireless Sensor Network technology extends numerous application domains and it is crucial that WSNs perform in reliable and robust manner. One of the major issues in the design of routing protocol for WSN is energy efficiency due to limited energy resources of sensors. This paper survey several different routing strategies for wireless sensor network. Therefore routing protocols designed for WSN should be energy efficient as possible to prolong the life time of individual sensors..

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