Comparison between Routing Technologies of Wireless Sensor Networks

Shivali Dhaka
Amity University,
Gurgaon, India
shivi359@gmail.com

Abstract-WSNs have crafted new prospects across the field of human activities, embracing monitoring and control of environmental systems, animal tracking, forest fire tracking, medical care, battlefield surveillance, calamity management. These different applications involves data collection from different millions of sensors and propagating to base stations via sink nodes. WSN makes this communication possible by forwarding data directly to base station that exhaust energy reserves. Use of multi-hop data transmission reduces loss of energy and increase lifetime of network. This paper discusses various routing techniques used in multi-hop WSN to select best path.

Keywords:*Wireless Sensor Networks, SPIN, LEACH, PEGASIS.*

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I. INTRODUCTION

WSNs have crafted new prospects across the field of human activities, embracing monitoring and control of environmental systems, animal tracking, forest fire tracking, medical care, battlefield surveillance, calamity management. These different applications involves data collection from different millions of sensors and propagating to base stations via sink nodes. The sensors deployed in the environment are used by many applications for the same purpose of information distribution [1]. They sensed the environment and record all the readings of parameters affecting target like humidity, temperature, weather etc. The practice of data gathering and furtheringhappensdue to activities performed by targets in the ecosystem where the sensors are deployed and work according to the instructions given to it by different applications.Some of the sensors work smartly by not forwarding each message individually rather send the data collectively thus leading to a meaningfulreduction in energy consumption due to communication between different nodes in Wireless sensor networks.Wireless Sensor network organized various wireless sensors to cover a large geographical section by making them moving away from base station. It works by making the base station and target area to communicate with each other by exchanging data and information with each other. The basic approach followed by the network to make this possible is by switching data directly with the base station. But on directly sending the data by each node to base station that is far away may exhaust their energy reserves rapidly, thereby severely restraining the lifetime of the network. Wireless Sensor Network makes use of multi-hop data transmission for exchanging the data to overcome the problems of single-hop method. Multi-hop methods reduce the communication obstruction between sensor nodescontending to access the channel, especially in highly dense WSNs and the depletion of consumed energy by increasing lifetime of network.In Multi-hop approach, multi-hop paths are used to disseminate information from target to destination [3]. In a multi-hop WSN, different routing strategies are used to select the best path for forwarding data packets between source and destination via intermediate nodes. In general, routing in large-scale networks is inherently a difficult problem whose solution must address multiple challenging design requirements, including correctness, stability, and optimality with respect to various performance metrics. But these routing algorithms have some routing challenges to be solved. This paper discusses various routing strategies for wireless sensor networks.

II. TRADITIONAL ROUTING STRATEGIES IN WIRELESS SENSOR NETWORKS

The most critical challenge for routing strategies is to balance overhead in the networks between the nodes. This overhead in the network is measured by utilization of bandwidth, power depletion, and the processing necessities on the mobile nodes. These routing algorithms need wise strategy to balance all such needs [2]. The routing algorithms for Wireless Sensor Network are classified into three groups: Proactive Strategy, Reactive Routing strategies and Hybrid strategies.

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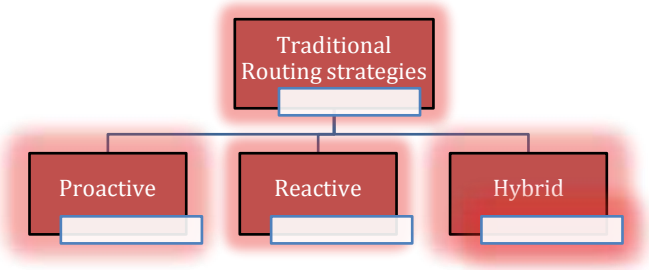

Figure 1. Categories of TraditionalRouting Approach

The proactive strategy, also called as table driven, relies on periodic propagation of routing information to maintain consistency with either flat or hierarchical network. Flat proactive routing strategies have the potential to compute optimal paths. Both help in computing paths in large Adhoc networks. Reactive routing strategies create routes on demand but they have to rely on a dynamic route search to establish paths between two endpoints. This typically involves flooding a route discovery query, with the replies traveling back along the reverse path. Hybrid strategies help to achieve constancy and scalability in huge networks. The whole network is organized into clusters maintained dynamically by different nodes[4]. A hybrid routing strategy can be implemented whereby proactive routing is used within a cluster and reactive routing is used across clusters. The main task of hybrid approach is to lessen the overhead needed to maintain the clusters. The table 1 and the Figure 2below are showing the major differences and frequency of usage between the three.

Table 1: Parametric Difference in Routing Strategies

Routing strategies / **Parameters**	**Proactive Strategy**	**Reactive Strategy**	**Hybrid Strategy**
Frequency of Routing	Periodic	On-demand	Both
Stored Information Location	Global	Local	Global
Path Creation	Static	Dynamic	Dynamic
Role of cluster	Used within cluster	Used across cluster	Both

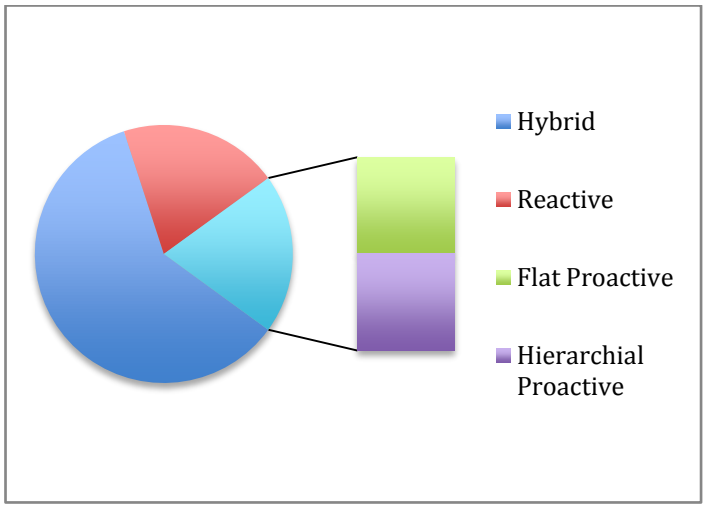

Figure 2. Ratio of usage of Routing strategies by WSN

Traditional routing algorithms for Wireless networks do not work accurately under highly dynamic conditions. Routing protocol overhead usually rises noticeably with enlarged network range and dynamics that helps in depleting network resources. Additionally, theses routing techniques demand coordination of all nodes and in few cases overall flooding, to retain consistent and precise information. New routing techniques are therefore required for sensor networks that are efficient of successfully controlling the trade-off between optimality and proficiency.

III. MODERN ROUTING APPROACHES IN WIRELESS SENSOR NETWORKS

The design of routing protocols for WSNs must reflect the stability of network in case of dynamic routing, no loss of data in case of link failure and proper functioning of nodes even in case of packet loss and delay. To overcome these design necessities, numerous routing strategies for WSNs have been proposed as discussed below.

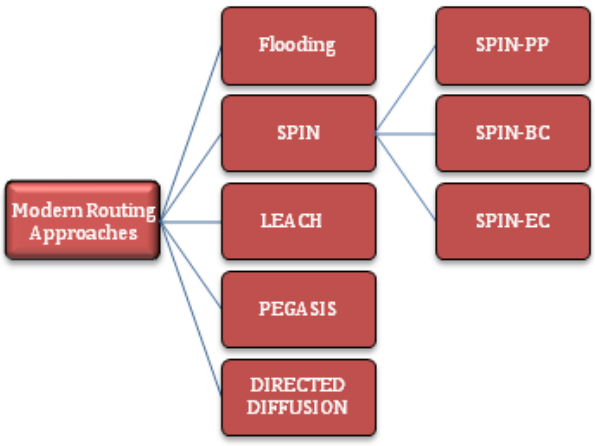

Figure 3. Modern Routing Strategies

A. Flooding

For communication and sending information between nodes Flooding is the most usual practice used recurrently both in wired and wireless sensor networks. The routing technique does not require maintenance and complex routing algorithms and is also cost effective [5]. In Flooding, each node receiving a data or packet sends the packet to all its neighbors that after transmission follows all possible paths in that particular network and follow new paths upon change of network topology. This technique leads replication of packets as every node in the network receives packet sent by other node.A hop count is included to prevent looping and wastage of resources and time.

B. Sensor protocols for information via negotiation (SPIN)

It is a data-centric negotiation-based family of protocols for WSNs that first learn the concept of the data before distributing between the nodes. The criticality of these protocols is to proficiently distributing information's gathered by individual sensor nodes to all the sensor nodes in the network and overcome the geographical overlapping and traffic implosion caused by earlier protocols. A negotiation is performed between sender and receiver leading to only transfer of particular data needed by the receiving party thereby reducing traffic explosion and redundancy in the network [6]. All the sensor nodes under SPIN keep track of resource consumption and defecate some of its events when current level of energy becomes low. The versions of SPIN are SPIN-PP, using a three-way handshake and SPIN-EC designed for point-to-point communication. Another version is SPIN-BC designed for broadcast networks. In these networks, nodes share a single channel for communications where a node sends out a data packet on the broadcast channel that is received by all the other nodes within a certain range of the sending node.

C. Low-Energy Adaptive Clustering Hierarchy (LEACH)

Low-energy adaptive clustering hierarchy (LEACH) is another modern routing algorithm aimed to gather and distribute data to the data sink, typically a base station. With LEACH lifetime optimization of network is achieved with reduced energy consumption by each network sensor node and also make usage of data aggregation method to lower the number of communication messages. The whole network using hierarchical approach is organized into clusters that are managed by cluster head. Cluster head collects data from all the members of clusters by removing redundancy and transmit the aggregated data directly to base station costing a single-hop [7]. Cluster head also generate a TDMA-based program whereby each node of the cluster has to transmit in given time slot. The cluster head advertises the program to its cluster members through broadcasting. LEACH protocol work basically in two distinct phases. The first phase, the setup phase, entails cluster-head selection and cluster formation. The second phase emphases on data collection, aggregation, and delivery to the base station.

D. Power-Efficient Gathering in Sensor Information Systems (PEGASIS)

Power-efficient gathering in sensor information systems comes under family of routing and information-gathering protocols for WSNs. Each node is having knowledge about other nodes in the network. This protocol aims at optimizing the lifetime of a network by attaining a high level of energy efficiency and uniform energy utilization across all network nodesdistributed uniformly in geographical area and also reduces the delay that packetssuffer on their way to the sink. Again the use of data aggregation is done to reduce redundancy and balancing energy utilization among sensor nodes. Its working depends upon the chain structure method in which nodes communicate with their closest neighbors. The formation of the chain starts with the farthest node from the sink. Network nodes are added to the chain progressively, starting from the closest neighbor to the end node. The strength of signal measures the closest neighbor. Again a chain leader is elected to transmit the aggregated data to the base station. The chain leader role shifts in positioning the chain after each round. It uses sequential scheme for data aggregation.

E.Directed Diffusion

Directed diffusion protocol deals mainly in conserving energy to enhance and optimize the lifetime of network [8]. This protocol keeps on interactingwith nodes by exchanging messagesconfined within a limited network area. Using confined interaction, direct diffusion can still recognize robust multipath delivery and adjust to a minimal subset of network paths. This exclusive characteristic of the protocol results into significant energy savings. Directed diffusion uses a publish-and-subscribe information model in which an inquirer expresses an interest using attributes–value pairs. An interest can be viewed as a query or an interrogation that specifies what the inquirer wants. For each active sensing task, the data sink periodically broadcasts an interest message to each neighbor node [9]. The message propagates throughout the sensor network as an interest for named data. The main ideabehind this exploratory interest message is to establish if there lastany sensor nodes that can service the sought-after interest. All sensor nodes maintain an interest cache. Each entry of the interest cache agrees to a distinctive interest. The cache entry includes several fields, including a timestamp field, multiple gradient fields for each neighbor, and a duration field. The timestamp field contains the timestamp of the last matching interest received [10]. Directed diffusion has the prospective for noteworthy

energy savings. Its localized interactions allow it to achieve relatively great performance over unoptimized paths. The Table 2 is depicting the main differences between different categories of Modern routing strategies.

Table 2. Parametric difference between modern Routing Techniques

Routing Strategies / Parameters	Flooding	SPIN	LEACH	PEGASIS	Direct Diffusion
Simple Strategy	YES	NO	NO	NO	NO
Replication of data packets	YES	NO	NO	NO	NO
Traffic implosion	YES	NO	NO	NO	NO
Overlapping	YES	NO	NO	NO	NO
Data centric	NO	YES	YES	NO	YES
Data Negotiation	NO	NO	YES	YES	YES
Lifetime optimization	NO	NO	YES	YES	YES
Data aggregation	NO	NO	YES	YES	YES
Structure Type	Tree	Hierarchical	Cluster	Chain	Tree/ Hierarchial

IV. CONCLUSION

The properties of WSNs and the features of the ecosystem within which sensor nodes are typically organized make the routing problem very perplexing. In this paper we concentrated on issues central to routing in WSNs and portray various techniques used to cultivate routing protocols for these networks. The modern routing techniques lead to selection of best path while sending data packets between two extreme ends. The lifetime of network is also optimized while conserving most of the energy wasted in sending information individually through single node. Multi-hop communication helps in data aggregation and wisely use of energy in a network.

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