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Qualitative Analysis of Routing Protocols in WSN

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ABSTRACT

Wireless Sensor Network (WSN) is partially distributed autonomous sensors to monitor physical or environmental conditions such as temperature, pressure etc. and to cooperatively pass their data through the network to the central location. The technique referred to as multi-hop wireless communications is used by the WSN's to communicate. Due to the limited processing power and the finite power accessible to each sensor nodes, the application of regular routing techniques is not recommended. Hence recent advances in wireless sensor networks have made the routing protocols more efficient. This paper surveys and compares the advanced routing protocols. The three main categories discussed here are flat based, hierarchical based and location based. The paper concludes with open research issues.

Keywords- **Flat based, Hierarchical, Location based, Routing techniques, WSN**

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I. INTRODUCTION

Micro–sensors development in recent times is due to microelectronic mechanical systems and low power and highly integrated digital electronics. MEMS are equipped with data processing and communication capabilities. The ambient conditions surrounding the environment are sensed by the sensory circuits and are converted into electrical signals. Properties of the objects located and the events happening in the locality of the sensor are obtained through the processing of such electrical signals. The radio transmitter collects the data sent by the sensor and sends it to a command centre also known as sink. The interest in the possible use of huge set of disposable unused sensors has increased because of the decrease in cost of sensors and size. Many researchers have been carried out the past years pointing to the potential of collaboration among sensors in data collecting and processing. The management and coordination of the sensing activity and flow of the data to the sink. A network with wireless links that is created among the sensors by an ad-hoc technique is the basic set up for such collaborative distributed sensors. Sensing over larger geographical region with greater accuracy is possible by a Wireless Sensor Network which has hundreds or thousands of these sensor nodes. Many applications that require operations which are unattended can be networked through WSN which possess ability to communicate by an external base station or directly among each other.

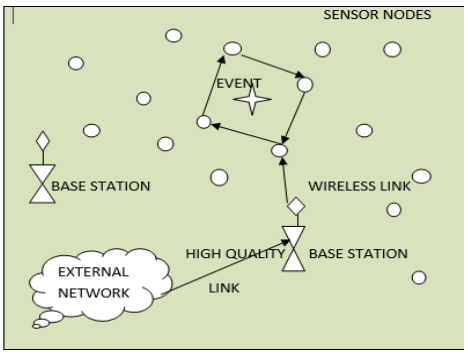

Fig 1. Wireless sensor Network

Sensor node components with each sensor node comprising of sensors, processors and transmission mobilizes forms a schematic diagram which is shown in figure 1. The sensor nodes gather and route the data to other base stations which have a mobile node capable of connecting the sensor network to present communication setup or to the internet which provides an access to the reported data to the users or directly to the other sensors. The sensor node has capability to base its decision of its mission and information it currently has and its computing communication, energy resources.

The deployment of the large number of sensor nodes leads to the close arrangement of the neighboring nodes. This helps in lowering the power consumption by the multi hop communication when compared to the single hop communication. To make the covert operation desirable the transmission power must be maintained at a lower level. The signal propagation effects experienced in long distance wireless communication can be effectively overcome by the

Usage of multi-hop communication. The requirement for the low power consumptions on the sensor nodes is its main drawback. The power sources used in sensor

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nodes are irreplaceable and are limited in number. Therefore, power conservation should be primarily focused in order to achieve high quality of service (QoS). To prolong the network lifetime the nodes must have inbuilt trade-off mechanisms. This results in the reduction of transmission delay. Many researches are progressing towards these developments. In this paper, survey of protocols and algorithms are proposed for sensor networks. This paper helps in understanding the current research issues in this field. This paper also contains the following: In section2, a brief overview on the various design issues and routing challenges are discussed. Three types of protocols and their categories are summarized in section3.

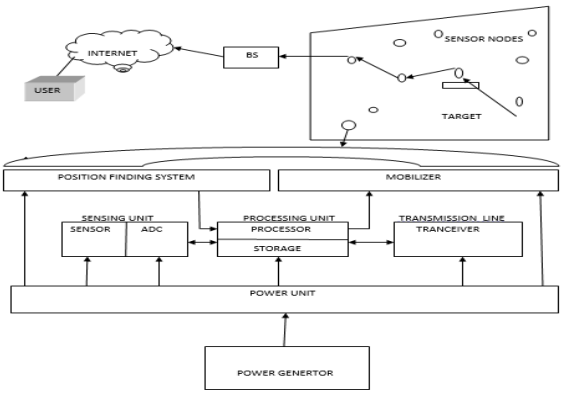

Fig 2. Components of Sensor Nodes

II. DESIGN ISSUES AND ROUTING TECHNIQUES.

Various design constraints and architectures are taken into consideration for sensor networks based on their applications. The routing protocols perform very similar to the architecture modeling. Therefore, in this section we look into the architectural issues and throw light on their implications.

2.1 Hardware resources limitation: Sensor nodes can perform limited computational functionalities, as they have limited processing, storage capacities and energy capacities. The design of software development and network protocols for sensor networks face many challenges offered by hardware constraints along with considering the energy constraints in sensor nodes. It also considers the processing and storage capacities of sensor nodes.

2.2 Node Deployment: One of the most fundamental issues to be solved in WSNs is Node Deployment. The complexity of problems in WSNs such as routing, data fusion, communication etc. can be overcome by the proper node deployment scheme. This also helps in reducing the power consumption thereby extending the life span of WSNs. The node deployments are either deterministic or random for large scale WSNs. The parameters with which the performance is measured are the distance coverage, energy consumption and message transfer delay.

2.3 Quality of service: Time constraint applications are bounded by another condition that is bounded latency for data delivery. In order to extend the total network lifetime and reduce energy dissipation in the nodes which are caused when the energy gets depleted, the network may have to be required to reduce the quality of the results. This majorly comes into picture in some of the applications where the data from the moment it is sensed should be delivered within a certain period of time otherwise the data will be useless. Hence to capture this requirement energy efficient routing protocols are required.

2.4 Adaptability: A node may fail, join, or move in sensor network which would result in changes in network topology and node density. It is necessary that the network protocols designed for sensor networks should be adaptive to such density and topology changes.

2.5 Fault tolerance: Sensor nodes are suffered to failures due to harsh deployment environments and unattended operations. So the sensor nodes should be fault tolerant. Sensors have the abilities of self calibrating, self-testing, self-repairing and self-recovering.

2.6 Scalability: The number sensor nodes in sensor networks are in the order of tens, hundreds, or thousands hence the network protocols designed for sensor networks should be scalable to different network sizes.

III. CLASSIFICATION OF ROUTING PROTOCOLS:

In many different ways we can classify the routing algorithms for WSNs which is having a large design space. In general, the classification of routing technique in WSNs is divided into flat-based routing, hierarchical-based routing and location-based routing depending on the network structure.

The first category considered is flat-based or the data-centric routing protocols. Node centric communication is not commonly used communication type in WSNs. Therefore, data centric routing protocols are designed for WSNs. Flat based routing protocols distribute information as needed to any router that can be reached or receive information. Here each router node routinely collects and distributes routing information with its neighboring routers. The entire participating node addressed by flat routing protocol performs an equal role in the overall routing mechanism.

The next category is hierarchical-based or cluster based routing protocols. A hierarchical routing protocol allows an administrator to make best use of his fast powerful routers in the backbone and the slower, lower energy routers may be used for network access at the edge of the network. Some hierarchical routing protocols also perform route aggregation to reduce the number of routes advertised. The cluster based routing

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protocols are more advantageous for WSN due to the higher energy utilization rate and being more scalable.
The last category is the location-based routing protocol. This type of protocol is used for energy efficiency in WSNs. The distance between neighboring nodes can be estimated by incoming signal strength. By exchanging information between neighbors relative coordinates of neighboring nodes can be obtained. We can determine the location of the nodes directly by communicating with a satellite, using GPS (Global Positioning System) if small low power GPS receivers are present in the nodes. Few location-based schemes demand that nodes should go to sleep when there is no activity in order to save energy. More the number of inactive nodes more is the energy saved. By using this type routing performance can be improved.

IV. COMPARISION OF ROUTING PROTOCOLS:

In this paper we have compared routing protocols according to their design characteristics which is shown in the table below.

4.1 Flat based routing.

- SPIN: Sensor Protocols for Information via Negotiation.
- Directed diffusion.
- Rumor routing.
- GBR: Gradient Based Routing.
- MCFA: Minimum Cost Forwarding Algorithm.
- CADR: Constrained Anisotropic Diffusion Routing.
- COUGAR
- ACQUIRE: ACquire QUery forwarding In sensoR nEtworks.

4.2 Hierarchical based routing.

- LEACH: Low Energy Adaptive Clustering Hierarchy.
- TEEN: Threshold Sensitive Energy Efficient sensor Network.
  APTEEN: Adaptive Periodic Threshold Sensitive Energy Efficient sensor Network.
- PEGASIS: The Power-Efficient Gathering in Sensor Information Systems.
- MECN: Minimum Energy Communication Network. SMECN: Small Minimum Energy Communication Network.
- SOP: Self Organizing Protocol
- HPAR: Hierarchical Power Aware Routing.
- VGA: Virtual Grid Architecture Routing.
- TTDD: Two-Tier Data Communication.

4.3 Location based routing.

- GAF: Geographic Adaptive Fidelity.
- GEAR: Geographic and Energy Aware Routing.
- SPAN
- GOAFR: The Greedy Other Adaptive Face Routing.

ROUTING PROTOCOLS	CLASSIFICATION	MOBILITY	POWER USAGE	DATA AGGREGATION	QoS	STATE COMPLEXITY	SCALABILITY	QUERY BASED
SPIN	Flat	Possible	Limited	Yes	No	Low	Limited	Yes
Directed Diffusion	Flat	Limited	Limited	Yes	No	Low	Limited	Yes
Rumor Routing	Flat	Very Limited	N/A	Yes	No	Low	Good	Yes
GBR	Flat	Limited	N/A	Yes	No	Low	Limited	Yes
MCFA	Flat	No	N/A	No	No	Low	Good	No
CADR	Flat	No	Limited	Yes	No	Low	Limited	No

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COUGAR	Flat	No	Limited	Yes	No	Low	Limited	Yes
ACQUIRE	Flat	Limited	N/A	Yes	No	Low	Limited	Yes
LEACH	Hierarchical	Fixed BS	Maximum	Yes	No	CHs	Good	No
TEEN & APTEEN	Hierarchical	Fixed BS	Maximum	Yes	No	CHs	Good	No
PEGASIS	Hierarchical	Fixed BS	Maximum	No	No	Low	Good	No
MECN & SMECN	Hierarchical	No	Maximum	No	No	Low	Low	No
SOP	Hierarchical	No	N/A	No	No	Low	Low	No
HPAR	Hierarchical	No	N/A	No	No	Low	Good	No
VGA	Hierarchical	No	N/A	Yes	No	CHs	Good	No
TTDD	Hierarchical	Yes	Limited	No	No	Moderate	Low	Possible
GAF	Location	Limited	Limited	No	No	Low	Good	No
GEAR	Location	Limited	Limited	No	No	Low	Limited	No
SPAN	Location	Limited	N/A	Yes	No	Low	Limited	No
GOAFR	Location	No	N/A	No	No	Low	Good	No

Table 1: Comparison of routing protocols based on their design characteristics

V. RESEARCH ISSUES AND FUTURE WORKS:

The common problem faced by wireless sensor networks (WSNs) is energy. When a sensor is drained out, it can no longer be able to achieve its goal unless the energy source is replaced. In WSN future works in routing techniques focuses on different direction which share the common aim of extending the network lifetime.

Some of them are:

- Designing more secured and more effective routing techniques.
- Achieving the density of the sensor nodes.
- To work on accomplishing redundancy and to employ fault tolerance in an effective way.
- Reducing delay time and improving energy efficiency.
- Synchronization of time and location.
- Further work includes research in the integration of sensor networks using internet i.e. with wired networks.

VI. CONCLUSION

In recent years routing in sensor networks has drawn huge attention and introduced new challenges compared to classic data routing in wired networks. We have given an extensive survey on data routing in sensor networks and categorized the techniques into three main classification namely flat based, hierarchical-based and location based in this paper. Even though many of these routing techniques look favorable, still they have many complications that required to be solved in sensor networks. We promoted those complications and defined some future work issues in this concern.

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