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Survey on Different Routing Issues and Design Challenges in WSN

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Abstract-Wireless sensor networks give us facility of collecting diverse types of data at frequent intervals-even multiple times per second-over large areas. Wireless sensor network (WSN) has come in existence as a solution to many problems where human intervention becomes difficult. Development in wireless sensor network (WSN) technology has provided the benefit of small and low-cost sensor nodes. These sensors have the capability of sensing various types of physical and environmental conditions, wireless communication and data processing. Variety of sensing capabilities results in abundance of application areas. However, Wireless sensor networks require different effective methods for data forwarding and processing. The sensor nodes in WSN have a limited transmission range. Sensors processing, storage capabilities and their energy resources are also limited. This paper gives a survey on characteristics of WSNs, design challenges and Routing Issues in Wireless Sensor Networks.

Keywords
Wireless Sensor Networks, Wireless communication, Routing Issues

I. Introduction

One of the most important technologies for the twenty-first century is the wireless sensor network (WSN) . It has received tremendous attention from both academia and industry all over the world in the past decades. Typically a wireless sensor network consists of a large number of low-cost, low-power and multifunctional wireless sensor nodes. These sensors with different capabilities such as sensing, wireless communications and computation. These sensor nodes communicate over short distance via a wireless medium and work together to achieve some common tasks such as environment monitoring, military surveillance, and industrial process control. The fundamental nature behind WSNs is that, even the capability of each individual sensor node is limited though the aggregate power of the entire network is sufficient for the required mission. The deployment of sensor nodes is performed in an ad hoc fashion without careful planning and engineering is observed in much WSN applications. After deployment the sensor nodes must be able to autonomously organize themselves into a wireless communication network. Generally, the sensor nodes are battery-powered and are expected to operate without attendance for a relatively long period of time. In most of the cases it is very difficult as well as impossible to recharge or change batteries for the sensor nodes. WSNs have different characterized with denser levels of sensor node deployment; sever power, computation, higher unreliability of sensor nodes and memory constraints. So, the unique characteristics and constraints present has to face many new challenges for the development and application of WSNs [1, 2, 3, 6].

The severe energy constraints of large number of densely deployed sensor nodes requires a suite of network protocols to implement various network control and management functions like node localization, synchronization and network security. Due to the energy-constrained nature of such networks the generation to generation routing

protocols have several shortcomings when applied to WSNs. For example, flooding technique in which a given node broadcasts data and control packets that it has received to the rest of the nodes in the network. Until the destination node is reached this process repeats. The energy constraint imposed by WSNs does not consider by this technique. It leads to the problems such as implosion and overlap, when used for data routing in WSNs [7, 8, 9, 12]. Thus the flooding technique is blind techniques where duplicated packets may keep circulate in the network and sensors will receive those duplicated packets, causing an implosion problem. The neighbors will receive duplicated packets when two sensors sense the same region and broadcast their sensed data at the same time. The gossiping technique can be applied to overcome these problems of flooding [10]. In gossiping technique after receiving a packet by sensor it would select randomly one of its neighbors and send the packet to it. This process repeats until all sensors receive this packet. By using gossiping technique, a given sensor would receive only one copy of a packet being sent. There is a significant delay for a packet to reach all sensors in a network while gossiping tackles the implosion problem. Furthermore, when the number of nodes in the network increases these inconveniences comes forward. To solve design and application issues and overcome the constraints of WSNs a large number of research activities have been carried out. This paper discuses various routing protocols for wireless sensor network. Also paper discusses the network characteristics and design objectives and the network design challenges and routing issues are described.

II. Characteristics of Wireless Sensor Network

The network characteristic have quick impact on network design. The traditional wireless communication networks like mobile ad hoc network (MANET) and cellular systems, wireless sensor networks have the following unusual characteristics and constraints:

1) Dense sensor node deployment: These sensor nodes can have several orders of magnitude higher than that in a MANET and they are usually deployed densely.

2) ***Battery-powered sensor nodes:*** These sensor nodes are usually powered by battery and are deployed in a harsh environment where it is very difficult to recharge or change the batteries.

3) Severe energy, computation, and storage constraints: These sensors nodes are having highly limited energy, computation, and storage capabilities.

4) Self-configurable: These sensor nodes are randomly deployed and autonomously configure Itself into a communication network.

5) Unreliable sensor nodes: Due to deployment of sensors in harsh or hostile environment. These sensor nodes are prone to physical damages or failures.

6) ***Data redundancy:*** In most application of sensor network, sensor nodes are densely deployed in a area of interest and collaborate to achieve a common sensing task. So the data sensed by multiple sensor nodes typically have a certain level of correlation or redundancy.

7) Application specific: A sensor network is typically designed and deployed for a specific application. With its application the design requirements of a sensor network change.

8) Many-to-one traffic pattern: In most applications of sensor network, the data sensed by sensor nodes flow from multiple source sensor nodes to a particular sink, showing a many-to-one traffic pattern.

9) Frequent topology change: Network topology changes frequently due to the node failures, energy depletion, damage, addition or channel fading.

III. Wireless Sensor Network Design Objectives

Most sensor networks are application specific and have different application requirements. Following all or some main design objectives are considered in the design of sensor networks:-

1) Small node size: Since sensor nodes are typically deployed in a severe or unfriendly environment in large numbers, reducing node size can easier node deployment. Also it reduces the power consumption and cost of sensor nodes.

2) Low node cost: Since sensor nodes are typically deployed in a severe or unfriendly environment in large numbers and cannot be reused, reducing cost of sensor nodes is important and will result into the cost reduction of whole network.

3) Low power consumption: Since sensor nodes are powered by battery and it is often very hard or even impossible to recharge or charge their batteries, it is crucial to reduce the power consumption of sensor nodes so that the lifetime of the sensor nodes, as well as the whole network is extend.

4) 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.

5) Reliability: Designed sensor network protocols must provide error control and correction

mechanisms for ensuring the reliable data delivery over error-prone, noisy and time-varying wireless channels.

6) Self-configurability: In sensor networks, once deployed, sensor nodes should be able to autonomously organize themselves into a communication network and rearrange their connectivity in the event of topology changes and node failures.

7) 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.

8) Channel utilization: Communication protocols designed for sensor networks should efficiently make use of the bandwidth to improve channel utilization because of limited bandwidth resources of sensor networks.

9) 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.

10) Security: To prevent the data information in the network or a sensor node from unauthorized access or malicious attacks, a sensor network should introduce effective security mechanisms.

11) QoS support: Different applications in sensor networks may have different quality-of-service (QoS) requirements in terms of delivery latency and packet loss. So the network protocol design should consider the QoS requirements of specific applications.

IV. Routing Issues and Network Design Challenges

Several network constraints the design of routing protocols for WSNs is challenging. WSNs affected badly by the limitations of several network resources such as bandwidth, energy, central processing unit, and storage [11, 13]. Following are the main aspects of design challenges in wireless sensor networks [4, 11, 13].

1) Limited energy capacity: Since sensor nodes are battery powered so they have limited energy capacity. Energy poses a big challenge for network designers in unfriendly environments, the best example is a battlefield, where it is impossible to access the sensors and recharge their batteries. The sensor will become faulty and will not be able to function properly when the energy of a sensor reaches a certain threshold, which will have a major impact on the network performance. Thus, routing protocols designed for sensors should be as energy efficient as possible to prolong their lifetime, and hence extend the network lifetime while guaranteeing good performance overall [5].

2) Sensor locations: The design of routing protocols challenge is to manage the locations of the sensors. Many proposed protocols assume that the sensors either are equipped with global positioning system (GPS) receivers or use some localization technique [14] to learn about their locations.

3) Limitation of hardware resources: Sensor nodes have limited processing and storage capacities with the limited energy capacity and thus can only perform limited computational functionalities. The hardware constraint offers many challenges in software development and network protocol design for sensor networks. It not only considers the energy constraint in sensor nodes, but also considers the processing and storage capacities of sensor nodes.

4) Massive and random node deployment: Deployment of sensor node in WSNs is application dependent and can be either manual or random. Finally it affects the performance of the routing protocol. There are many applications where sensor nodes can be scattered randomly in an intended area or dropped massively over an inaccessible or unfriendly region. When the resultant distribution of nodes is not uniform then optimal clustering becomes necessary to allow connectivity and enable energy efficient network operation.

5) Unreliable environment and network characteristics: Typically sensor network operates in a dynamic and unreliable environment. Senor defines the topology of a network where the communication links between the sensors changes frequently due to sensor addition, deletion, damages, or energy depletion and node failures. The sensor nodes are linked by a wireless medium, which is error prone, noisy and time varying. Hence, the routing paths should consider network topology dynamics due to limited energy and sensor mobility and also with increasing the size of the network to maintain specific application requirements in terms of coverage and connectivity.

6) Aggregation of Data: The sensor nodes may generate significant redundant data and similar packets from multiple nodes can be aggregated to reduce the number of transmissions. To achieve energy efficiency and data transfer optimization in a number of routing protocols the data aggregation technique has been used.

7) Diverse sensing application requirements: Sensor networks have a huge range of diverse applications.

There is no network protocol which meets the requirements of all applications. Hence the routing protocols should guarantee data delivery and its accuracy so the sink can gather the required knowledge about the physical phenomenon on time.

8) Scalability: Routing protocols must be able to scale with the network size. The sensors may not necessarily have the same capabilities in terms of processing, sensing, energy and particularly communication. Therefore the communication links between sensors may not be symmetric means a pair of sensors may not be able to have communication in both directions. The routing protocols should be take care of these things [15].

Conclusion

Now a day's wireless sensor network have been used in everywhere such as school, colleges, battle field etc. Wireless sensor networks provides the facility of collecting diverse types of data from temperature to imagery and sound at frequent intervals and even multiple times per second over large areas. Wireless sensor networks are extending current capabilities and will allow researchers to conduct studies that are not feasible now. So this paper discusses the characteristics of WSNs .Also discusses the design challenges and routing issues in wireless sensor network.

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