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A Review of Wireless Sensor Network with Its Applications

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***Abstract*— In past few years there is a rapid development in the field of wireless sensor network. This paper gives brief introduction of wireless sensor network with its applications in the field of environment, structure monitoring, intelligent home monitoring, Industrial application, health, military, vehicle detection, congestion control and RFID tag. With advancement in WSN, small and low cost sensor nodes become available, which have capabilities of wireless communication, sensing various types of environmental conditions and data processing. There are different types of routing protocols depending upon application and network architecture. Routing protocols provide path in the network and efficient multi-hop communication. WSNs can be found in a various applications like civilian and military worldwide which embrace enemy intrusion detection, object tracking, patient monitoring, habitat monitoring, fire detection and battlefield.**

***Keywords*— Wireless sensor network, Routing protocols, Flat routing protocol, Clustering based protocol, Location based protocol, Applications.**

I. INTRODUCTION

Wireless sensors monitor various factors such as pressure, temperature, vibration and conciseness when arranged in a spatially distributed network [1]. Data is sent cooperatively to the monitoring location where it is processed. Wireless sensor network is a network of large number of mobile and static sensor nodes that forms wireless network using multi-hop and self-organization method [2]. Its main purpose is collaboration of detection, processing and transmission of the information of object monitoring in the areas of network coverage. It is basically a network of minute devices capable of computation, communication and sensing. WSN provides a bridge between real and virtual worlds. It has capability to observe previously unobservable at a time resolution over large spatiotemporal scales.

WSN consists of programmable micro devices or sensor nodes which monitor various parameters of the environment [17]. The 3 essential parts of sensor network are sink node, sensor node and target node. Sensor nodes are backbone of whole network; these are responsible for data acquisition, processing and transmission of data. The collected data is forwarded to the sink node that's why the sink node is placed in such a way that it has great impact on lifetime and energy consumption of WSN [18]. The components of sensor nodes are assembled on a single PCB or more than one PCB depending on the application.

The technologies used in WSN are time synchronization, network protocol, localization, security administration, data aggregation and power management. In WSN study of routing protocols is a key point .The routing of WSN differs in various ways from conventional routing of fixed network. Problems occur in WSN are no infrastructure is employed, wireless links are unreliable, sensor nodes may fail and the protocols must be energy efficient.

II. ROUTING PROTOCOLS

Because of presence of different network constraints, routing protocols become challenge for WSN. Design of WSN suffers from several network resource limitations like bandwidth, energy, storage and central processing unit. For the purpose of communication data is exchanged between sensor nodes and base station using routing protocols.

Routing Protocols can be categorized into proactive, Reactive and Hybrid on the basis of type of target applications and Mode of functioning. These can also be classified into Flat, Clustering and Direct Communication Protocols on the basis of Participation style of the nodes. Last but not the least can be characterized into Hierarchical, Location based and Data Centric protocols on the basis of Network Structure.

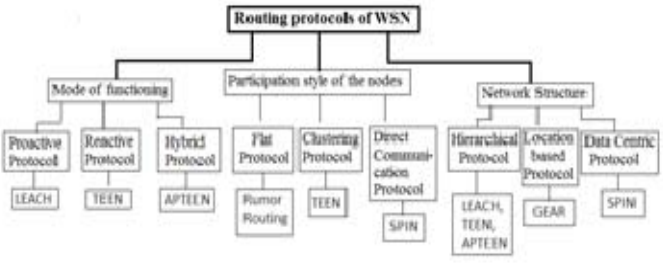

Fig1. Routing Protocols

In a Proactive Protocols, sensor nodes and transmitters are used to sense the ambience and send the data acquired through sensors via the predefined route to a Base Station after they are switched on. Example of Proactive Protocols is LEACH (Low Energy Adaptive Clustering Hierarchy) is a MAC protocol based on TDMA. It is combined with general routing protocol and clustering in wireless sensor networks. The purpose of LEACH is to improve the life

time of wireless sensor networks by increasing their energy efficiency which is an important aspect for creation and maintenance of clusters [3].

In Reactive Protocol nodes immediately react if the sensed attribute undergoes sudden changes beyond some threshold value, which is predefined. The use of this protocol is basically in time restricted applications [1] and TEEN is one example of a protocol which can be used for such applications. Threshold sensitive Energy Efficient sensor Network (TEEN) is used where there is a need to instantaneously transmit critical data to the user. Hybrid Protocols combines the concept of both Proactive and Reactive protocols. Their function is to calculate all routes available and then improvisation is done during routing. Adaptive Periodic TEEN (APTEEN) is considered as an instance of Hybrid Protocols is APTEEN maintains three different types of queries: First one is one time, in which a view of the whole network is taken in the form of snapshot, second is historical in which analysis of past data values is done and third is persistent in which for a particular period of time and event is monitored [11].

In Direct Communication Protocols, the information can be sent directly from a node to the base station. The energy of sensor nodes may drain quickly by applying in a very large network. Scalability of these protocols is very small. SPIN is one example of this type of protocol. Nodes running SPIN illustrate their collected data i.e. meta-data in the terms of high level language and meta-data negotiations are executed before transmission of data [4]. In addition, SPIN can acquire the current energy level of the node and easily adapts the running protocol on the basis of remaining energy [12]. SPIN has three kinds of messages: Advertisement (ADV), Request (REQ) and DATA as shown in Fig2. :-

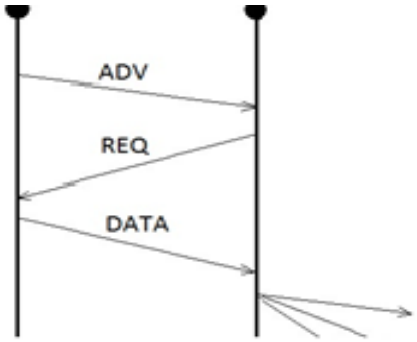

Fig2. Sensor protocol for information via negotiation (SPIN)

In Flat Protocols, during transmission of data form any node, a valid route which is shortest path to the Base Station is first searched and then data is transmitted. Energy may be quickly drained from the nodes around the base station. Rumor Routing is considered under an instance of this type of protocol. In this technique shortest path can be established by circulating agents which are basically packets in the network. When a node is found which has longer path than a path found by agent, then routing table is updated by agent. Sink generates a query which is sent on a random walk to find a path for required event. If event path is not found out by query then the sink times out and the query is propagated though flooding.

In clustering protocol, many clusters are formed to divide a particular area. Each and every node present in a group of nodes transmits their data to the corresponding head called the cluster head, which is assigned to every group of nodes present in WSN. Cluster head is in direct communication with the base station. Data Centric protocol is based on query and gives name to the desired data which eliminates redundancy in transmission. BS sends query to the particular region of nodes and waits until they reply. Accordingly particular data is collected by sensors from interested area, which is required to be transmitted to the base station. This reduces number of transmissions. Hierarchical routing is a type of routing which is energy efficient. There are two types of nodes present. First one is high energy nodes which take part in processing and sending of information. Second one is low energy nodes which are basically used to sense the interested area. The examples are: examples: TEEN, APTEEN and LEACH.

Location based routing needs information about location of sensor nodes which can be obtained from received radio signal strength, GPS signals etc. [4]. By using this protocol, we can form optimal path without using flooding techniques [12]. The example of this protocol is GEAR. In this technique, each node is having a learning cost and an estimated cost to reach the target through neighbors. The estimated cost basically combines distance to destination and residual energy. The learned cost is transmitted to the previous hop every time a packet reaches the target in order to adjust setup of a route for the next packet [11]. The disadvantages of flooding technique are Resource Blindness, Implosion and Overlap. In the problem of overlapping overlapped data is sent from different nodes to same node. Implosion creates duplication of message which must be avoided [12].

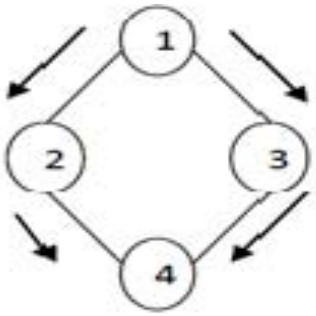

Fig3. Example of Implosion [12]

Flooding wastes lots of energy and time by sending duplicate copies and overlapped data [12]. The modified version of flooding is gossiping. In order to avoid implosion, the neighbors are randomly selected and then data is sent though nodes. The disadvantages of Gossiping are: There is no guarantee of receiving message by all nodes of the network. Propagation of message throughout the network is time consuming [11].

III. APPLICATIONS

Sensor network is mainly installed for data acquisition and remote monitoring purposes. Here are the applications where wireless sensors plays vital role.

A. Environmental applications

WSN is becoming an integral part for monitoring of pollution in air, water quality monitoring, natural disaster deterrence, forest fire detection, landslide detection,. These applications involve sensing temperature, light, humidity and quality of air. For monitoring of environment technical knowledge about wireless networks and its protocols is not sufficient. The knowledge about ecosystem is necessary condition.

B. Health care applications

These applications are characterized in two ways: wearable and implantable devices. Wearable devices are used on the body and implantable devices are implanted inside the human body. Sensors can be used to monitor the location, body position and measurement of ill patients in hospitals as well as in home. For example, sensors are deployed in patients home to examine the position and behavior of patient. If patient falls and require instant attention, it gives signal to doctor for immediate assistance [1].

C. Agricultural applications

It involves precision agriculture monitoring to check environmental conditions effecting crops by tracking birds, insects and other animals. Soil moisture and air humidity can be detected by wireless sensor network in order to control irrigation. The advantages using WSN in agriculture is low power consumption, less cost, self-organizing property which includes rapid deployment of network. By the use of wireless sensor network farmers need not to bother about maintenance of wiring in different environmental conditions. Pressure transmitters can be used to monitor water tank levels in order to monitor gravity feed water.

D. Structural monitoring

To monitor condition of building, movement inside building, construction, bridges & flyovers. With the use of WSN buildings, bridges, flyovers and other structures can give their status statistics to the management and then management can repair buildings according to their priority. That's way these structures are known as intelligent buildings.

E. Intelligent home monitoring

The intelligent living environment provides more comfort and convenience to human beings. WSN is deployed to run all sorts of furnishing automatically and work together. Smart home environment is synergy of technology and services by using home networking for safety, communication, security, comfort, energy savings and automating. Such as wireless sensors are deployed to read utility meter in a home like gas, water, electricity and then transmit readings the distant centers.

F. Military applications

Wireless sensors network has characteristics like strong concealment, fault tolerance and self-organization as so the wireless sensor network can be used effectively in military Communication, Command, Targeting system Control and Computing, Intelligence, Surveillance, Reconnaissance [1]. Many countries have spent their resources to research in this direction. "Smart dust" is a current project going on which is military application research project. Temperature, light vibration, magnetism, or chemicals can be detected using smart dust which is basically a system of many minute micro electromechanical systems (MEMS) such as robots, sensors or any other devices [2] . "Smart dust" is a system of low power, ultra-miniature sensor, computing power and low cost.

G. Industrial applications

WSN is used to monitor conditions of manufacturing equipment and manufacturing processes. They enable new functionality and provide significant cost savings. Wireless sensors can be positioned in locations where it is not possible to reach such as rotating machinery and untethered vehicles. Sensors give alert alarm in case of any failure occurred. Wireless sensor network plays an important role in date logging, as live data feed is possible though sensors.

H. Vehicle detection

Tracking and detection of vehicle has become an important application in the field of WSN. Advanced Vehicle Location system is made up of two GPS systems, one is built-in GPS satellite receiver that is basically used to compute accurately the position of vehicle and other one is the reliable GSM network to transmit the position coordinates to a control center [8]. The system with features like two way voice communication and SMS capability, paves way for an efficient management and emergency handling framework.

I. Congestion control

Reducing the road traffic congestion is a major challenge for city authority. This system will be built based on sensor network which will detect the congestion on the road and broadcast the congestion information to the drivers in order to detour for avoiding congestion [6], [7], and [19].

J. RFID indoor tracking system

WSN along with RFID (Radio frequency identification technology) tag is deployed to provide location-based service more to give more precise results according to different needs. Using RFID low cost tags are deployed on objects and human beings in order to monitor and track their position in limited indoor area. WSN-RFID convergence is considered in context-aware systems with indoor positioning capabilities, where data from WSN and RFID systems can be used to improve and upgrade the position information associated with collected data. RFID Tag Indoor Localization by Fingerprinting methods is a promising research in the field of WSN [5].

IV. CONCLUSIONS

In this paper we have seen there are unlimited applications of WSN. There is a comprehensive survey of routing protocols, their functions and a complete comparison of different types of protocols. Overall, routing Protocols can be categorized based on the type of target applications, mode of functioning and participation style of nodes. Scalability of flooding is poor. WSN is an evolving technology that shows promising applications both for military and mass public. Besides these applications, vehicle detection and congestion control are main issues which can be reduced by using WSN.

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