AN INTRODUCTION TO MOBILE WIRELESS SENSOR NETWORKS

[1]Surbhi Munjal, [2]Dr. Charanjit Singh,
Electronics and Communication Department,
Punjabi University, Patiala, India

Abstract : ***With the growing demand of advancement and better result in wireless sensor networks (wsn), inventors came up with a solution of mobile wireless sensor networks (mwsn) in which according to requirement any component of network is made mobile i.e. given the ability to move in the network. It is great approach as it resolves many existing issues like limited area coverage, power failure and limited network lifetime. In this paper an introduction to mwsn is provided highlighting the construction and working of various aspects of mobility in wsn along the challenges faced by developers.***

IndexTerms – Wireless sensor networks, mobility, energy efficiency, wide area coverage

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I. INTRODUCTION

As the name stands for, a mobile wireless sensor network (mwsn) is a network in which its components are movable in nature. A wireless sensor network (wsn) usually consists of a sensor, a sink and user end [10]. A mwsn is similar to that WSN with same components having ability to move. MWSNs are adaptable in nature [11], this quality of it provides leverage to the fact that being mobile in nature this network can catch up with changing technology [12] wide area coverage optimised use of power and increased lifetime[13,14]. Now in MWSN the mobility can be caused by movement of sensor, sink, user or combination of any components. Usually for movement of sensors, the nodes are either implanted (with mobilizers, robots) or made self-propelled (with springs, wheels) [15] or are made to move by environment (ocean waves or air) [1][2].Major advantage of mobile wsn over stationary wsn is that in stationary or static network fails immediately as soon as the nodes, especially those away from base station, lose their energy first but if nodes are provided with mobility they will consume less energy [16] thus enhances the lifetime [2]. Also mobile wsn outdo static wsn in terms of architecture, dynamic topology[17], lifetime, relocation, more channel capacity[18], better targeting[19], improved connectivity[20] and fidelity of network [2]. This paper will explore mobility scenarios of wsn, application of mwsn, architecture, routing techniques, protocols followed, issues and challenges in real time scenarios and future of mwsn.

II Mobility scenarios in wsn

There are basically three broad scenarios to provide mobility in wsn.

A) Sink Mobility [3] explores the sink mobility and concludes that any node which is nearer to sink has less energy consumption. There are three approaches to provide sink mobility i.e. MBS (Mobile Base Stations), MDC (Mobile Data Collector) and Hybrid approach. When base station is moving in the network and collects data from cluster heads then this approach is known as MBS. It increases the coverage area and decreases the multi-hop possibility [4].When data collectors or cluster heads are mobile in nature than this approach is known as MDC [5]. Here the concept of data on demand works which means only when data is demanded, it is collected. Hybrid approach is mixture of approaches i.e. a sink can act as both data collector and base station [6].

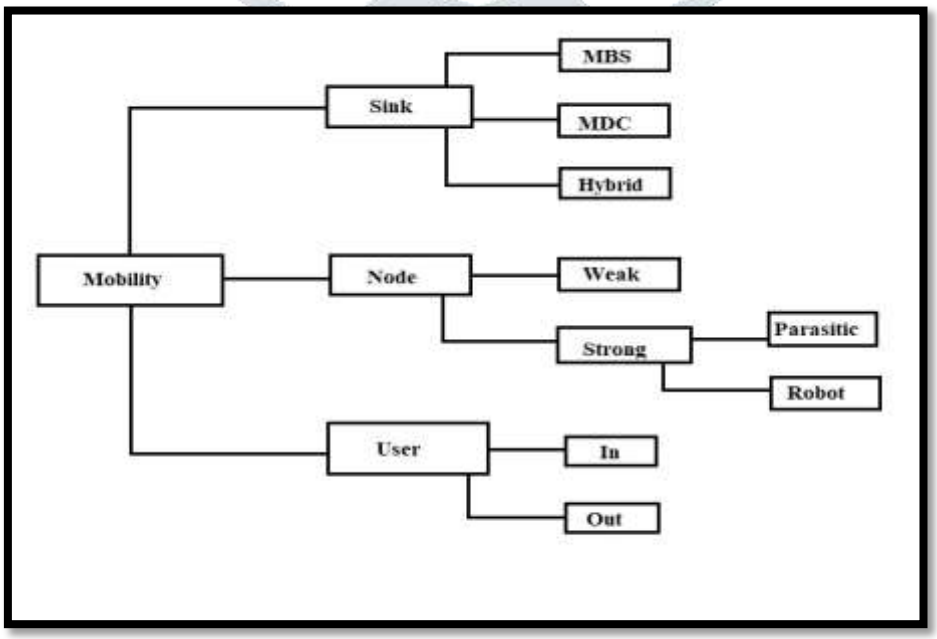

Fig. 1 Classification of mobility in WSN

B) Node Mobility:- It is of 2 types [7] One is weak mobility which happens due to weaken battery life of nodes that leads to exhaustion and ultimately leads to network failure. Other is strong mobility that occurs due to extrinsic factors as well as intrinsic factors of nodes.

C) User Mobility:- It focuses on movement of user inside the network [8]. If a customary infrastructure is considered, the user is free to connect to any of the gateways (In approach) and if a non-infrastructure network is considered than the user is free to move inside clusters and sensor fields (Out approach).

III Application of mwsn

A) Industrial Application:- Networks have always been used in industry for surveillance and monitoring purposes. Mobile wsn is of great use when it comes to process automation and monitoring health of equipments, motors, bearings etc.[21]. It can also be useful to for security and disturbance detection along with keeping record of detouring health of the setup [22].

B) Environment Monitoring:- Due to mobility of components of network, the user is able to monitor various atmospheric and climatic changes of remote and hazardous locations like forest fires, volcanic eruptions, floods etc.

C) Health Monitoring:- MWSNs are of great significance when it comes to home-based monitoring, pre-hospital and in-hospital emergency care, heart and pressure related situations. It helps medical supervisors for fast track treatment and on time responses. [9]. By use of implantable sensors, endoscopic capsules and wearable devices one can monitor the health of themselves and their loved ones [23][24].

D) Agriculture Monitoring:- WSN is a distributed network thus a lot a factors can be monitored at once like moisture of soil, humidity, precipitation, nitrogen level etc [25]. This helps farmers to have detailed analysis of soil and thus they can imply precise farming techniques to get the optimum yield. It will also help to reduce water pollution and check ground water level [26]. It is also advantageous to reduce soil erosion.

E) Transport:- For unmanned vehicles like space shuttles, rockets, submarines etc mobile wsn are of great advantage. Being mobile and compact in nature these nodes can collect data at various locations of a single vehicle and can help control the machinery manually from a distant location.

F) Security:- For locations of national importance providing security is a great hurdle but with the help of mobile wsn security can be provided at optimum level. It makes use of movable security camera, thermal and noise sensors along with infrared lasers to detect any kind of intrusion and suspicious access. It is also useful for security of toddlers and old citizens under guidance to prevent any abuse.

IV Architecture

[10] explains the various architectures of mwsn. The general idea is explained here by figure 2. A mobile wireless sensor network consists of three layers i.e. lower layer, middle layer and higher layer [27]. Sensors are the major component of lower layer, they sense the factors and convert it into raw data in form of facts, figures and numbers and communicate them to the higher layers. Now the mobile agents present in medium layer are the backbone of these wireless sensor networks. These mobile agents have the ability to go to and fro inside the network. Their purpose is to collect data from sensory nodes in lower layer and transfer this data to access points in higher layers. Mobile agent's behaviour and response ability can help to increase the efficiency of wsn in terms of performance and energy. Higher layer usually consists of access points that form a network to provide communication between the lower layers and base station.

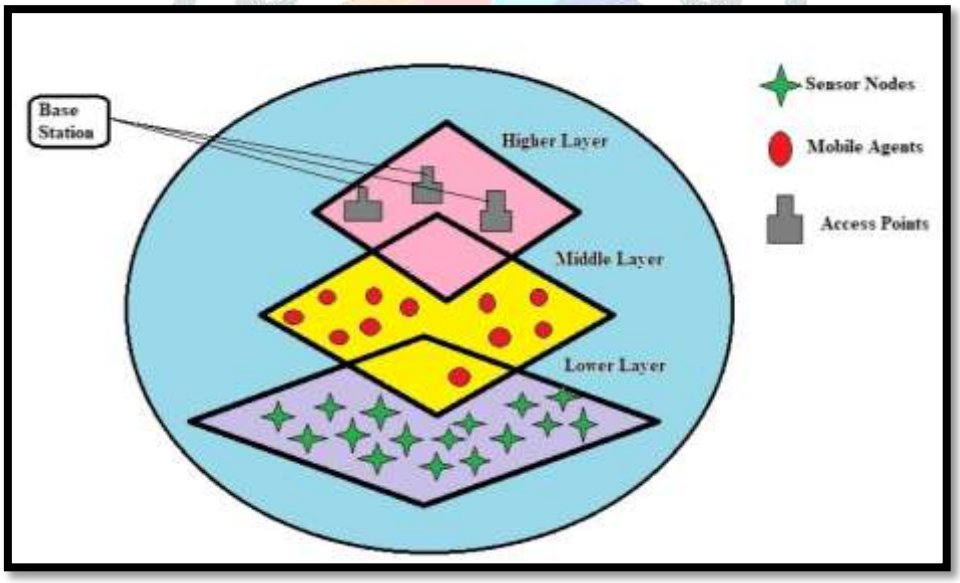

Fig.2 Basic architecture of mobile wsn.

Various networking models like mesh and ad-hoc or mesh without ad-hoc can be deployed on this architecture. The mobility nature of wsn can be varied thus the topology is varied accordingly. But it is important to note that the dependency of components on each other remains the same i.e. an access point will always be dependent on sensor nodes to provide data. Hence it becomes important to maintain this basic process keeping in mind that the output is energy efficient, less expensive, maintains stability and is long lasting.

V Routing In MWSN

Routing is the decision making process for selection of best path to move data from place to another. From sending emails to running daily errands one always seeks to find a way that will avoid delay and is highly efficient. In networking, routing plays a great role while transferring data because if routing algorithms are not implemented than there will be no sense of co-ordination between sink and source. [2] explains the various routing techniques which are classified according to their properties, applications and course of actions. Further they have sub-classes and then they are compared on the basis of their merits and demerits.

There are 5 classifications of routing protocols according to [2]

A) On the basis of network structure.

A network can be on a small, medium or wide area network. It is further divided into three types which are as follow:-

i) Direct Communication Routing:- Here the node sends data directly to access points or base stations disregarding the distance between them thus exhausting itself shortly.
ii) Flat Based Routing:- In this all the nodes are considered equivalent in terms of task assignment thus most suitable for compact networks. It has further two sub categories, one of them is opportunistic routing (OR) in which a set of nodes are considered and are given priorities. Priority is set according to closeness with sink i.e. node with highest priority will be used first to transfer data packet. Other is best path routing (BPR), as the name suggests in this the approach is to determine the efficient path for transferring data packets across network.
iii) Hierarchical Routing:- It suggests dynamic clustering of nodes. Each cluster has a cluster head, responsible for data collection, processing and delivering it to base station. Selection of cluster head is based upon probability.
B) Based upon state of information
It is of two types i.e. Topology based and location based.
i) Topology based:- In this the information of the entire network is stored in every node thus giving access to complete topology [28]. Based upon this, it is subcategorized into proactive, reactive and hybrid routing. Proactive routing makes use of routing table that stores all the information and keeps updating it whenever the topology changes. Reactive routing works on demand and supply model i.e. routing is done only when it is required, it doesn't involve unnecessary updating every time any change occurs. Hybrid routing is mixture of both the approaches.
ii) Location based:- In this nodes share their location and position and regularly provide this information to server [29] It uses three types of location update approaches i.e. time based, distance based and predictive distance based. Time based location update occurs periodically by the nodes in the network to the base station. For distance based location update a threshold distance is preset thus a node sends an update whenever it is crossed during its movement. Predictive distance based location update involves envisaging the movement pattern of nodes based upon the distance it moved and position it attained by some velocity.
C) Energy Efficiency Techniques
A sensor node consumes energy while sending and receiving data every time it is required. Even when data is not transferred by a node due to changing topology each node updates itself thus consumes energy at great level thus it becomes necessary to have energy efficient protocols [30]. Energy efficiency requires proper use of energy along with proper conservation of energy. These two are the main challenges of energy algorithms. Various approaches such as sleep mode, predictive data collection routing techniques and load distribution have been used in various ways to conserve energy. As conservation of energy is directly linked to network lifetime thus it becomes necessary to design such algorithms that don't get limited by few restrictions such as area or ground level realities.
D) Based on applications
As the deployment area of mwsn is different thus the routing technique implied has to be different. Each application of mwsn demands unique approach of mobility of nodes. For example in case of dense forest areas where there is high risk of fires or wild animals a mobile wsn is required whereas in case of security mixed wsn is required. Based upon such scenarios routing algorithms are designed keeping in mind which component of wsn is mobile and what is the extent of mobility.
E) Biological Routing techniques
These techniques are inspired from living creature's (other than humans) survival and habitation techniques. According to [31] it is of two types i.e. swarm intelligence and evolutionary computing. Swarm intelligence includes ant colony optimization, bee colony optimization and particle swarm optimization whereas evolutionary computing are inspired by genetic algorithms specifically designed for routing.

VI Design Issues and Challenges

Mobility can be a boon in any network but it comes with certain challenges associated specially with performance of network. [9] explains various issues which are as follow
A) Loss of communication:- Because of mobility, a node may get admitted to such area of network where coverage is minimised thus it leads to zero contact between mobile agents and those who are controlling them thus it leads to loss of data as well.
B) Power management:- Sensor nodes are usually mounted on robots or mobilizers that are equipped with limited energy thus in case when their energy drains out, the node mounted over it may be considered dead even if the energy of node is not over. Thus a synchronization of energy for both node and robot is required.
C) Mobility management:- If a number of nodes are mobile in nature than it becomes important to manage them in context of area coverage and prevention of over lapping. It is important to do so in order to get best results.
D) Data reliability:- Data abundance and data reliability are the major issues in any network. When mobile agents are collecting data it might be possible that multiple agents may collect data from same source for various number of times hence it becomes difficult for destination to sort and keep important data as bulk of data is present.
E) Interference from neighbour nodes:- Sensor nodes are electromagnetic in nature constantly emitting and receiving signals thus not properly insulated they might interfere in working of other nodes and equipments.

VII Conclusion

MWSN can be of great use from serving in commercial applications like military, surveillance to domestic applications like smart house, smart transport system etc. Surely, mobile wireless sensor network is a great update to static wireless sensor network in terms of performance, output, reliability and area coverage but it comes with its own challenges of security, management and power issues. Also a traditional model for implementing mwsn cannot work because each real time scenario requires a different approach for the set up hence it becomes important to learn about the requirements and user must make balance between theoretical and practical implications. With the advancement in communication technology along with electrical technology mwsn will surely prosper and yield more and more outstanding outputs.

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