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A Study of Wireless Sensor Networks- A Review

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Abstract- The chief function of wireless sensor networks is to forecast and collect the data from the main demesne, process the data and then transmit this data to the destination node. Now, for proper functioning, it requires some energy efficient mechanism so as to make paths between the source (sensor nodes) and the sink node. The path to be chosen should be in such a way so that the lifetime of the network is greatly increased. Wireless sensor network is emerging field because of its wide applications and least cost. It is a wireless network which subsist a group of small sensor nodes which communicate through radio interface. These sensor nodes are composed of sensing, computation, communication and power as four basic elements. But limited energy, communication capability, storage and bandwidth are the main resource constraints. In WSNs, Energy is a scarcest resource of sensor nodes and it determines the lifetime of sensor nodes. These are battery powered sensor nodes. These small batteries have limited power and also may not easily rechargeable or removable. Long communication distance between sensors and a sink can greatly drain the energy of sensors and reduce the lifetime of a network. In WSNs, energy is a big factor to be considered. Various techniques are used to optimize energy level of sensor nodes of WSN. In this paper, basics of WSN are discussed in terms of architecture of WSN and wireless sensor node. This paper also presents the types of WSN along with its challenges. As clustering is one of the techniques that can improve the efficiency of a node, so clustering and its parameters are also included in this paper.

Keywords- WSN, Nodes, Energy, Communication, Efficiency, Clustering, Sensor, Network

I. INTRODUCTION

Wireless Sensor Network technology has recently emerged as a very powerful technique for any applications. It has the potential to boost economic growth by revolutionizing communication and control in challenging environments. It has evolved as a promising solution for a wide range of applications, enabling wireless sensing, communication and automation as an ultimate real-time solution. UWSN consists of a number of spatially distributed sensor nodes which perform cooperative monitoring by relaying the sensed data from one another through the network to a data sink and further to the base station. [1]

II. WIRELESS SENSOR NETWORK

WSN is different from other popular wireless networks like cellular networks, wireless LAN and Bluetooth in many ways. WNS are proposed for variety of monitoring applications. In these networks (Fig.1) large number of nodes periodically takes measurements of environmental data and transmits them to a central data sink. The basic step of working of WSN: Sensing-> Computation->Communication->Data aggregation at sink node->various applications. With the development in wireless technology and embedded device technology, the capacity of the sensors is quite improved while their cost is lower. A wireless sensor network composed of hundreds to thousands of sensor nodes with much shorter distance between adjacent nodes and low application data rate.WSN has more opportunities to be deployed in real environments.

In recent years WSN becomes emerging field in wide range of applications like health monitoring applications, environmental observation, forecasting system, battlefield surveillance, robotic exploration, monitoring of human physiological data etc.

The sensors can be deployed at various places with different usages and each have different capability to sense different attributes like temperature, moisture, pressure humidity etc. But these sensors have limited power sources and also it is not cost effective to recharge the batteries. The batteries are usually irreplaceable. Therefore, there lifetime will depends on respective batteries of sensors. So the life time of wireless sensor network can be prolonged by using effective energy balancing methods. [2]

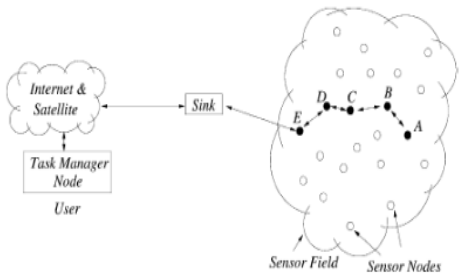

Fig. 1- WSN [1]

III. COMPARISON OF WSN WITH TRADITIONAL WIRELESS NETWORK

Number of sensor nodes in WSN is much larger than any of traditional wireless networks.

- A major difference between WSN and other traditional networks computing devices including PC's, PDA's and other embedded devices is that in WSN main emphasize is on power management.
- WSN is a data centric approach but traditional wireless networks are address centric because of large number of nodes in WSN.
- Sensor nodes are much cheaper than nodes in other wireless networks.
- WSN uses broadcast communication approach but traditional wireless networks use point-to-point communication.
- Traditional wireless network like Mobile ad hoc Networks are designed for distributed computing while WSN are designed to gather information.
- A unique characteristic of WSN is that data collected by adjacent nodes and some consecutive readings sensed by sensors are highly correlated which gives opportunity to develop efficient protocols 802.11-like MAC in traditional wireless networks consumes 2–6 times more energy than S-MAC for traffic load with messages sent every 1-10s.[3]

IV. ARCHITECTURE OF WIRELESS SENSOR NETWORK

WSN architecture includes both a hardware platform and operating system designed. TinyOS is a component based operating system designed to run in resource constraint wireless device.

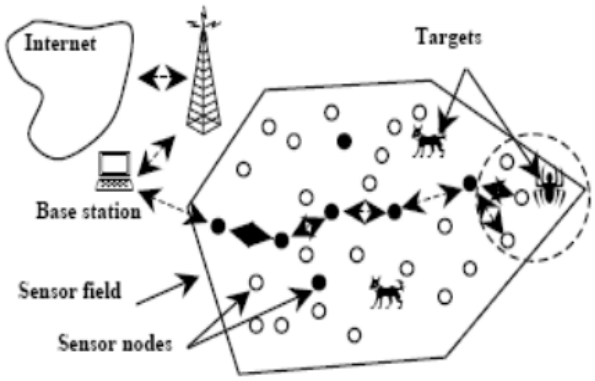

Fig.2- WSN Architecture [2]

The major components of WSN are (Fig.2):

Sensor Field
The area in which sensor nodes are deployed.

Sensor Nodes
Sensor nodes are the sensors which are responsible for gather information and routing this information back to a sink.

Sink
It is also a sensor node which performs a special task of receiving, processing and storing data from other sensor nodes. This node is responsible for reduction of messages need to be sent and also reduce the energy requirements.

Task Manager (Base Station)
It is a centralized point of control within the network used to extract information from the network and passes control information back to the network.[4]

V. ARCHITECTURE OF WIRELESS SENSOR NODE

A Sensor is a tiny device which is based on micro sensor technologies with low signal processing capability, low computation power and low bandwidth. Main Components of wireless sensor node (Fig.3):

- Sensor Unit.
- Processing Unit.
- Radio Transreceiver.
- Battery.
- Analog to Digital Convertor.
- Location Finder.
- Mobilizer.

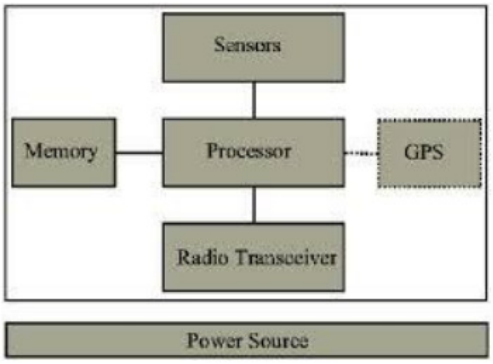

Fig.3- WSN Node Architecture [4]

VI. PROTOCOL STACK OF WSN

Sensor network protocol stack is much like the traditional protocol stack with the following layers (Fig.4):

Application Layer
Three possible application layer protocols, i.e., sensor management protocol (SMP), task assignment and data advertisement protocol (TADAP), and sensor query and data dissemination protocol (SQDDP),needed for sensor networks based on the proposed schemes related to the other layers and sensor network application areas.[6]

Transport Layer
It provides communication of network with outside world.

Network Layer
This node providing internetworking with external networks.

Data Link Layer
Like traditional network's Data link Layer it provides multiplexing of data streams, medium access and error control.

Physical Layer
It is responsible for frequency selection, signal detection, encryption and modulation. This layer also minimizes the energy.

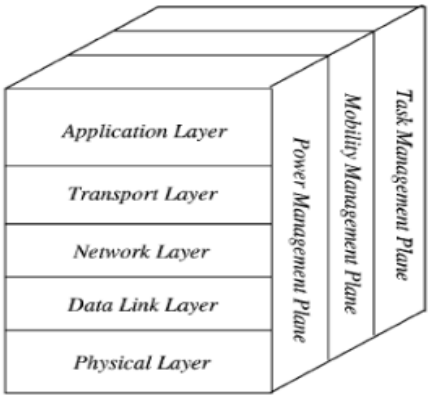

Fig.4- Protocol stack for WSN [5]

VII. TYPES OF WSN'S

Categorization of sensor networks on the bases of interfaces in which nodes are deployed. [6]

A) Underwater Wireless sensor network
In this sensor network sensor nodes are deployed under water. Sensor nodes communicate through acoustic waves. Underwater wireless communication today is expensive, sparsely deployed, typically communicating directly to a base-station over long ranges rather than with each other. This network is difficult to establish due to limited bandwidth, long propagation delay and signal fading problem.

Applications:

1) Seismic monitoring: A promising application for underwater Sensor networks is seismic monitoring for oil extraction from underwater.
2) Equipment Monitoring and Control: Underwater equipment monitoring is a second example application. Ideally, underwater equipment will include monitoring support when it is deployed, possibly associated with tethered power and communications, thus our approaches are not necessary.

B) Underground Wireless sensor network
This network is basically established under the ground and used to monitor the underground situations. It is a challenge to communicate via this network due to signal loses and high attenuation. In this network communication is carried out through electromagnetic waves. Underground sensors are expensive because the special components should be used for reliable communication through interfaces like soil rocks, water and other minerals. This type of WSN is also very expensive.

Applications:
- Earthquake and landslide monitoring.
- Intruder detection.
- Environment monitoring.
- Assisted navigation.
- Infrastructure maintenance.
- Sports field maintenance.

C) Earthbound Wireless sensor network
This type of networks also called terrestrial WSNs. This network is cheaper to deploy than the above two. In this thousands of nodes are deployed in ad hoc or in a pre planned manner. In former case nodes are placed randomly into target area while in latter there can be grid, optimal, 2D, 3D placements.

Applications:
- Military applications.
- Environmental Monitoring.
- Security.
- Node tracking system.
- Medical applications.
- Industrial application.
- Monitoring of human physiological data.
- Forecasting.

D) Mobile Wireless Sensor Network
In this type of network once the nodes are deployed they move to gather the information. And sensor node has ability to reposition and organize itself in network. Localization, self organizations, navigation and control, coverage, energy, maintenance, data process etc. are main features of mobile WSNs.

Applications:
- Sensors can be attached to people for health monitoring, which may include heart rate, blood pressure etc.
- Animals can have sensors attached to them in order to track their movements for migration patterns, feeding habits or other research purposes.
- Sensors may also be attached to unmanned aerial vehicles (UAVs) for surveillance or environment mapping.

E) Multi-media Wireless sensor networks
These are used to monitor and track events in the form of multimedia. These networks consist of a number of low cost sensors equipped with cameras and microphones. Main features of multi-media WSNs are high bandwidth/low energy, Quality of service, filtering, data processing and compressing techniques.

Applications:

- Traffic monitoring.
- Pollution control.
- Smart healthcare.
- Disaster/Emergency response.
- Smart Environmental sensing.

F) Wireless Nano sensor network

The concept is based on integrated machines at the nano scale, which interact on cooperative basis by means of wireless communications. At the present stage, the design of the protocol suite for wireless nano sensor networks represents a fundamental issue to address for accelerating the deployment process of such a technology.

VIII. CHALLENGES TO WSN

A) Energy Support

Most important restraint in a WSN is limited energy support of sensor nodes. Since sensor nodes are deployed in adhoc manner and after deployment they left unattended. So initial battery power is the main source of their lifetime survival. Once sensor nodes are deployed they could not be recharged. So today to establish an energy efficient wireless sensor network is a great issue and a challenge.

B) In Real Time Environment

WSN deal with real world environments. In many cases, sensor data must be delivered within time constraints so that appropriate observations can be made or actions taken. Very few results exist to date regarding meeting real- time requirements in WSN.

C) Ad-Hoc Deployment

Sensor nodes are distributed randomly in required monitoring field. For example –for monitoring forest activities sensor nodes are dropped from the plane. Then sensor nodes itself create connections with other nodes and form an infrastructure. Hence new standards and protocols should be developed to maintain this type of ad-hoc network.

D) Wireless Channel

The wireless channel is unreliable in nature, and a number of phenomena can prevent a transmitted packet from reaching a receiver. One such phenomenon is interference. If two independent transmitters transmit on the same channel such that their signals overlap, they may corrupt each other's signal at a receiver's radio. This requires the transmitter to re-transmit, at the cost of additional time and energy. So to maintain efficient wireless channel is a great challenge today.

E) Fault Tolerance

Sensor nodes are prone to failure because of unattended environment. A sensor node may fail due to hardware or software problem or energy exhaustion. If a few of sensor nodes fail, working protocol should handle this type of fault tolerance.[7, 8]

IX. CLUSTERING

Wireless sensor networks consist of sensor nodes equipped with their own battery having limited lifetime, which makes the operations of network available only within a limited amount of time. It is crucial to examine and estimate how long the network is properly functioning, or network lifetime. In WSN field the various clustering techniques are used. Hierarchical clustering, Partitioned clustering. In hierarchical, on the nesting cluster's characteristic, separation is based. Nested hierarchical clustering means that within bigger clusters it also clustered to exist. Partitioned clustering constructs Varieties of partitions and evaluate them. In clustering approach each cluster consists a cluster head (CH) and some regular nodes. Sensor nodes are source nodes. Sensor nodes take information from the regular nodes and send that information to their corresponding cluster head. From all the sensor nodes a cluster head is selected in a cluster and it has the responsibility for collecting sensing data from all source nods. After receiving of data from source nodes, the data aggregation is also performed by CH to reduce the data size. [3]

X. CLUSTERING PARAMETERS

In WSNs clustering algorithms, it is reporting on some important parameters related to the whole clustering procedure in WSN.

A) Number of clusters

In clustering algorithms the CH selection and formation process lead to variable number of clusters. In some published approaches, however, the set of CHs are predetermined and thus the numbers of clusters are preset. The amount of clusters is generally a critical parameter pertaining to the efficiency of the total routing protocol

B) Intra-cluster communication

In some initial clustering approaches the communication between a sensor and its designated CH is assumed to be direct. However, multi-hop intra-cluster communication is often required, the number of CHs is bounded when the communication range of the sensor nodes is limited or the number of sensor nodes is very large.

C) Cluster formation methodology

When CHs are regular nodes and time efficiency is a primary design criterion, clustering is being performed in a distributed manner without coordination. In few earlier approaches a centralized approach is followed; one or more coordinator nodes are used to partition the network off-line and control the cluster membership.

D) Cluster-head selection

The cluster heads of the clusters in some proposed algorithms (mainly for heterogeneous environments) can be

pre-assigned. Generally however in homogeneous environments, the CHs are picked from the deployed set of nodes either in a probabilistic or completely random way or based on other more specific criteria (residual energy, connectivity etc.).

E) Algorithm complexity

In most recent algorithms the one of the primary design goals is fast termination of the executed protocol. Thus, the time complexity or convergence rate of most cluster formation procedures proposed nowadays is constant (or just dependent on the amount of CHs or the amount of hops). In some earlier protocols, however, the complexity time has been allowed to depend on the total number of sensors in the network, focusing in other criteria first.

F) Multiple levels

In several published approaches the idea of a multi-level cluster hierarchy is introduced to achieve even better energy distribution and total energy consumption (instead of using only one cluster level). The improvements offered by multi-level clustering can be further studied, especially when we have very large networks and inter-CH communication efficiency is of high importance.

G) Overlapping

Several protocols give also high importance on the idea of node overlapping within different clusters (either for better routing efficiency or for faster cluster formation protocol execution or for other reasons).[5]

XI. CONCLUSION

Wireless Sensor Network is one of the emerging fields in research area. Wireless sensor network has a remarkable feature to monitor environmental and physical conditions. In the future, the wide range of application areas will make sensor networks an integral part of our lives. Wireless sensor network has bright future in the field of networking because it continuingly providing us solutions for many monitoring problems. This paper converse about various aspects of WSN. There are various types of WSN's and establishing a WSN is a challenging task. In this paper, types of WSN and its challenges are also highlighted. As, every new approach is based on some traditional approach(s), this paper tinted the difference which shows that how WSN is differ from traditional wireless networks. WSN and its nodes are made of some major components which are also conferred. In the last section stress is given to clustering and Clustering process in WSN can improve the efficiency of network and optimal clustering of nodes can guarantee the minimum power consumption. Review of various techniques will be helpful for better study and inventing new ideas for even better energy efficient techniques. Also it can conclude that to make the Wireless sensor network, energy efficient is one of the great areas for future work.

REFERENCES

[1] Beenish Ayaz, Alastair Allen, Marian Wiercigroch, "*Dynamically Reconfigurable Routing Protocol Design for Underwater Wireless Sensor Network*", Proceedings of the 8th International Conference on Sensing Technology, Liverpool, UK, Sep 2-4, **2014**.

[2] Ankita, "*A Survey on Wireless Sensor Network based Approaches*", International Journal of Advanced Research in Computer Science and Software Engineering, Vol 4, Issue 4, April **2014**.

[3] Stefanos A. Nikolidakis, Dionisis Kandris, Dimitrios D. Vergados and Christos Douligeris, "*Energy Efficient Routing in Wireless Sensor Networks Through Balanced Clustering*", algorithms ISSN 1999-4893, Open Access, Algorithms, Pg-29-42, **2013**.

[4] Umesh B.N, Dr G Vasanth and Dr Siddaraju, "*Energy Efficient Routing of Wireless Sensor Networks Using Virtual Backbone and life time Maximization of Nodes*", International Journal of Wireless & Mobile Networks (IJWMN), Vol 5, No.1, Feb **2013**.

[5] Saraswati Mishra and Prabhjot Kaur, "*Comparison of energy efficient data transmission approaches for flat wireless sensor networks*", International Journal of Advanced Smart Sensor Network Systems (IJASSN), Vol 4, Nov 3, July **2014**.

[6] Avijit Mathur, Thomas Newe, "*Comparison and overview of Wireless sensor network systems for Medical Applications*", Proceedings of the 8th International Conference on Sensing Technology, Liverpool, UK, Sep 2-4, **2014**.

[7] S.Ranjitha and D. Prabakar and S. Karthik, "A Study on Security issues in Wireless Sensor Networks", International Journal of Computer Sciences and Engineering, Vol-03, Issue-09, Page No (50-53), Sep -**2015**.

[8] Amr M. Kishk, Nagy W. Messiha, Nawal A. El-Fishawy, Abdelrahman A. Alkafs, Ahmed H. Madian, "Proposed Jamming Removal Technique for Wireless Sensor Network", International Journal of Scientific Research in Network Security and Communication, Vol -03, Issue-02, Page No (1-14), Mar -Apr **2015**

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