

AN INTRODUCTION TO WIRELESS SENSOR NETWORKS, ITS CHALLENGES AND SECURITY

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Abstract - The popularity of WSN has been enormously on a peak just because of its sensing technology. WSNs are in great demand now a days due to increasing growth in wireless devices. WSN is composed of small size, battery powered sensor nodes which collect, process, store and transfer the sensed data from one sensor to another. This efficiency makes sensor network to be used for many applications like military application, health application, environmental application, home application, commercial application etc. and many more. Node mobility, stability, throughput of network and its node, clustering, Energy efficiency, lifetime of sensor node are challenging issues of WSN and due to this WSN has gained worldwide attention of researchers. Basically the researchers intention is to form sensor network performs with maximum stability and minimum consumption of energy, so that they can work for long time. Batteries used in WSN can neither be changed nor recharged so it is necessary to improve the lifetime of the network for better performance of WSN. For researchers it is a dare to design energy efficient routing protocol for WSN.

Key Words: Sensor Node, Cluster Head, Base Station, WSN, Clustering

1. INTRODUCTION

A wide range of sensor nodes (SN) shapes a Wireless sensor network. Sensor nodes are low price, battery operated, multi-functional and deployed to form a sensor field. Each node have sensing unit, a processing unit, communication unit and power unit. Each and every node is able to perform smart sensing, neighbor node discovery, data gathering, data processing, data storage and communication with other nodes. The sensing unit senses the surrounding, the processing unit calculates the confined permutations of the sensed data, and the communication unit performs interchange of processed data among adjoining sensor nodes.

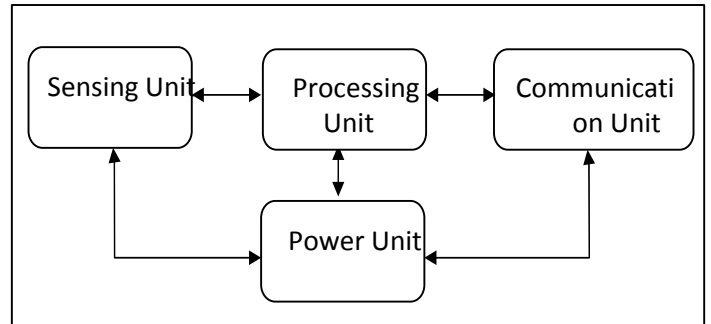


Figure 1.1- Building block of Sensor Node

Wireless Sensor Networks is group of sensors which are associated by wireless media. Sensors are deployed in network and communicate with each other for data collection. Then they forward the collected data to the Base Station. Clustering is a process of merging sensor nodes to form clusters and selecting cluster heads for each clusters. Sensor node gathers the data and send it to cluster head which is then forwarded to base station (BS). Clustering raises the stability of network and lowers the energy consumption of sensor nodes.

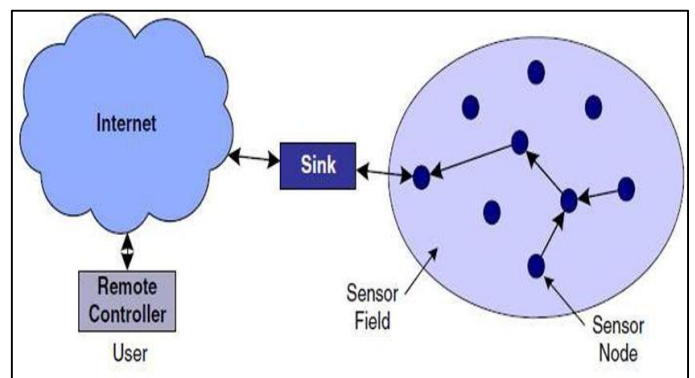


Figure 1.2- Architecture of a typical WSN

Attributes like size of the cluster, distance of sensor nodes from CH, distance of the BS from the cluster head influence the energy consumption in sensor nodes. More the distance of sensor nodes from the cluster head greater the energy dissipation for the data transmission.

Clustering process has three phases. Cluster head selection phase, cluster's setup phase and steady phase. The given

figure illustrate the formation of distant clusters in WSNs. These clusters have dissimilar type of sensor nodes and each node pass on the sensed information to the desired CH which is responsible for forwarding the sensed data to the sink node. Homogeneous and Heterogeneous are two forms of clustering in WSN.

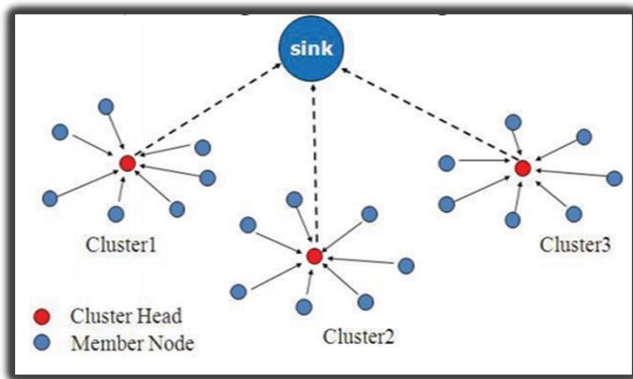


Figure 1.3- WSNs Cluster Formation

Homogenous Clustering

In homogeneous clustering, all nodes have equivalent energy. The life of Wireless sensors node depends on life time of the battery. There are many energy saving methodologies which are mainly introduced to lessen the energy consumption and thereby resulting in a mechanism for enhanced stability of the nodes. There are many protocols for homogeneous WSNs like LEACH, PEGASIS and HEED protocol. These algorithms will give poor performance in the heterogeneous type of network.

Heterogeneous Clustering

In heterogeneous WSNs, sensor nodes have distinct initial energies. SN have relatively excessive energy develop into cluster head. Stable Election Protocol, Distributed Energy Efficient Clustering, Threshold Sensitive Stable Election Protocol, Enhance threshold sensitive stable election protocol, Dual Cluster Head Routing Protocol and “DCHRP with level four Heterogeneity are various protocols of heterogeneous WSNs. Heterogeneous sensor networks are considered significant in WSNs because they are related to real life situation.

2. CHARACTERISTICS

WSN include various topologies like star, tree, mesh etc. for communication. Characteristics of good WSN include mobility, reliability, power efficiency, stability. WSN include these feature proves beneficial for human welfare that’s why it has variety of application in different field like medical, military, traffic control etc. Some other characteristics of WSNs are-

- Simple to use
- Network is flexible
- Utilization of power is limited because of battery
- It handles node failure effectively
- It deals with mobility and heterogeneity of Sensor Node.
- Can work with large scale distribution that is have high scalability
- Has ability to maintain strict environmental condition for execution
- Has unique cross layer design

3. WSN ORGANIZATION

Wireless sensor network shadows the OSI model. The architecture of WSN composed of five layers (physical, data link, transport, network and application) and three cross layers (power management, mobility management and task management). These layers collectively are used to complete the network and make the sensors work in an organized way, in order to raise the efficiency of the network.

- Physical layer is accountable for frequency selection, modulation and data encryption and signal detection.
- Function of Data link layer is to provide a pathway for multiplexing the data streams, data frame detection, error control, MAC.
- For data supply network layer is used. It is accountable for routing the information received from transport layer i.e. finding the optimal path for data packet to travel from source to destination.
- The flow of data is needed when the sensor network make use of internet which is maintained by the transport layer.
- Application layer is present at last and forms software and hardware transparent to the end user. It is responsible for presenting collected information and traffic management

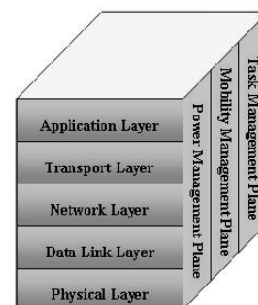


Figure 1.4- WSN organization

4. SECURITY IN WSN

Security plays a significant role in WSN. Sensitive data is carried by sensor nodes which may be targeted by attackers.

Attacks are occurred in any system just because of lack of security features

- Wireless communication is used in WSN, eavesdrop is possible.
- Injecting malicious node in WSN is a cake walk for the attacker.
- Vast number of nodes in WSN enforces security complexity at all levels.
- Resource constraints of sensor nodes pose another threat to security of the network in terms of memory, energy, processing power etc. Hence Symmetric cryptography or symmetric encryption is used because asymmetric cryptography becomes too expensive.

Conventional security techniques used earlier cannot be directly or indirectly applied on WSN. Security becomes extremely important when sensor networks are deployed, as they are susceptible to various malicious attacks because of its transmission nature, resource restriction and deployment in harsh environment. So existing security mechanisms are not enough for WSN, and new ideas are needed.

Symmetric key techniques, asymmetric key techniques and hash functions are crypto mechanisms used for achieving security in wireless sensor networks, it is extremely important to authenticate and encrypt messages sent between sensor nodes. WSN are very constrained in terms of battery power, node lifetime, stability, throughput, computing, and communication. WSN needs a light weight cryptographic algorithm.

WSN's main security aims are confidentiality, integrity, authentication, availability, survivability, along with efficiency, freshness and scalability.

5. ISSUES AND CHALLENGES IN DESIGNING WSN

- Resource limitation (Limited memory, computation and power)
- Maintenance of WSN is difficult.
- Sensor node depend only on battery and the batteries can neither be recharged nor replaced. Hence the hardware design consideration is must.
- While deploying, the sensor nodes are scattered so they can't fit into any regular topology.
- Reliability of communication is another issue that should be considered (Unreliable data transfer, Conflicts and latency are some if the challenges of WSN's)
- Topology changes, Node failure, addition and deletion of nodes is among other challenging issue in WSNs.
- Transmission nature, hostile environment of WSN and security are some of the challenging issue.
- Attaining synchronization between nodes is also another issue.

6. APPLICATIONS OF WSN

Wireless Sensor Networks comprise of numerous types of sensors such as seismic, thermal, low sampling rate magnetic, infrared, visual, acoustic and radar. These sensors are able to monitor a wide variety of ambient conditions like humidity, temperature, lightning, vehicular movement, pressure, soil makeup, noise levels and so on. WSN application can be classified into following categories:

- Military applications (enemy tracking, security detection, surveillance)
- Environmental applications (air pollution detection, landslide detection, forest fire detection, animal tracking, water quality monitoring, natural disaster prevention, flood detection, weather prediction,)
- Healthcare applications (implanted, wearable and surrounding embedded medical devices, monitoring and tracking of doctors and patients,
- Home applications (smart lighting, cooling and heating devices)
- Industrial applications (data logging, wine production, structural and machine health monitoring etc.)
- Transportation application (monitoring of traffic, dynamic routing management

7. ADVANTAGES

- Flexible infrastructure
- Easily implemented
- Fruitful for society
- Can deal with numerous nodes at a time
- Made up of three distant topologies(mesh, tree, star)
- It can be deployed on vast scale
- Can be monitored and accessed with remote locations
- Support embedded systems
- Increasing the number of sensor nodes is easy.
- Execution is cheap
- Saves cost as it avoids plenty of wiring.
- Suitable for unreachable areas such as over the seas, mountains

8. DISADVANTAGES

- WSN possess lower storage capacity (approx. few hundred kilobytes)
- Comparatively less secure than wired network
- Hackers can easily hack sensor network and acquire all data.
- Slow Communication and transmission speed
- SN are more prone to failure
- Easily distracted by its surrounding
- Slow processing power
- Works for short communication range
- Require minimal energy efficient protocol
- Have batteries with limited lifetime
- Need of extra equipment for setup like computer

9. CONCLUSIONS

Over the last few years hyper efficient design of WSN has become a leading platform for research and development. WSN started a revolution in technical field and attracts researchers toward it. Its sensing technology enhance its popularity worldwide. Researchers in WSN mainly focuses on hike in lifetime and stability of sensor nodes. Major research areas of WSN are distributed signal processing, data fusion, energy efficient routing algorithms, and security of WSN. WSN has highly influenced our life in all aspects. It has wide range of applications. With the short introduction of WSN, its organization, characteristics and challenges have been discussed as well the application of WSN have been highlighted along with the advantage and disadvantages of WSN.

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