# Decomposition of a Wireless Sensor Flow Network into Sub – networks and the Network Survivability

K. S. Suganthi
Department of Information Technology,
Sri Manakula Vinayagar Engineering College.

K. P. GnanaPreetha
Department of Information Technology,
Sri Manakula Vinayagar Engineering College.

## ABSTRACT

This paper contains an overview of some of the advantages that can be obtained by the decomposition of an underlying sensor flow network into sub-networks. Out of the various benefits that can be obtained, we have presented in this paper an idea about the optimized energy reduction and hence survival of the nodes in a network. The method of decomposing a network into sub-networks is based on the idea that smaller networks consume less energy during transmission and also for deducing a highly – resilient multipath routing to a wireless sensor network. Sensor networks offer ease of deployment and multiple functionalities. These properties are further enhanced in the sub – networks.

## General Terms

Sub–networks, Nodes, Decomposition, Energy consumption.

## Keywords

Wireless Sensor Network, Network Decomposition, Network Survivability.

## 1. INTRODUCTION

Wireless sensor network refers to a group of dispersed and dedicated sensors for monitoring and recording the physical conditions of an environment and organizing the collected data at a server placed in a remote location. Wireless Sensor Networks measure environmental conditions like temperature, sound, pollution levels, humidity, wind speed and direction, pressure, etc. These networks consists of distributed sensors that are built-up using nodes which range from a few hundred to several thousands, where each node is connected to at least one sensor or many sensors at cases. Wireless Sensor Networks have a set of characteristics that contribute to its functionality. The set of characteristics include power constraints for nodes using batteries or energy harvesting, ability to cope with node failures, mobility of nodes, dynamic network topology, communication failures, heterogeneity of nodes, scalability to large scale deployments of the wireless sensor networks, ability to withstand harsh environmental conditions, ease of use, unattended operation and power consumption.

These sensor networks consist of several low – power functional sensor nodes that are deployed to operate in an unattended environment, with limited computational and sensing capabilities. The advantage of using wireless sensor nodes is their compact physical dimensions that permit the deployment of numerous sensor nodes in accessible terrains. These nodes are also employed in data processing and routing functions. In order to make use of the features present in the wireless sensor networks, we also need to take into considerations the various constraints it faces. One particular constraint is minimizing energy consumption in the design of sensor networks protocols and algorithms. The design of wireless sensor networks also demands other requirements such as fault tolerance, scalability, production costs, and reliability.

Smart environments represent the development era which rely on the sensory data from the real world. These sensory data are obtained from multiple wireless sensors present at distributed locations with different modalities. Sensor networks play a vital role in gathering information to be provided to the smart environments. Sensor networks are deployed in providing counter measures to the terrorist warfare attacks as it is practically impossible to use wires or cables. Sensor networks prove to be better than the traditional networks by two ways, one being that, the sensors can be positioned far from their actual phenomenon and the other being that, they can be deployed only for sensing. A sensor network has fast installation and provides ease of maintenance. Each node in a sensor network consists of a few desirable functions that include ease of installation, self – identification and diagnosis, reliability, time awareness for communication with other nodes in the network and also require some standard protocols and network interfaces.

## 2. SYSTEM ARCHITECTURE FOR WIRELESS SENSOR NETWORK

The sensor nodes are scattered in a wide range which is known as the sensor field. Each of the nodes in this distributed performs the function of data collection and routing it back to the sink and hence to the end user. The sink communicates with the task manager node through Internet or satellite.

The challenging part with the installation of the existing models is the node initialization. This required a node to obtain the local view of the entire network it is present in. The problem arises in larger network coverage where the nodes are distributed over a wide area. This can however be, simplified by decomposing the underlying flow network into sub-networks and hence reducing the coverage area. This makes it easier for node initialization as the node is provided with a localized view of the entire network with much ease. Figures 1 and 2 show the Sensor Network Architecture and the Components of a Sensor Node.

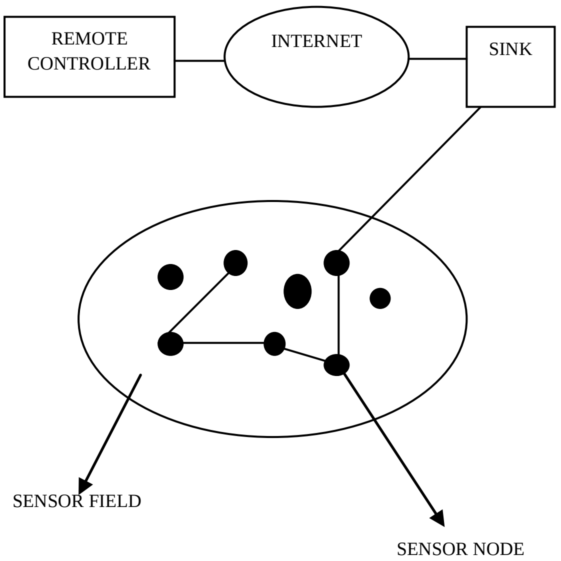


**Fig 1 : Sensor Network Architecture**

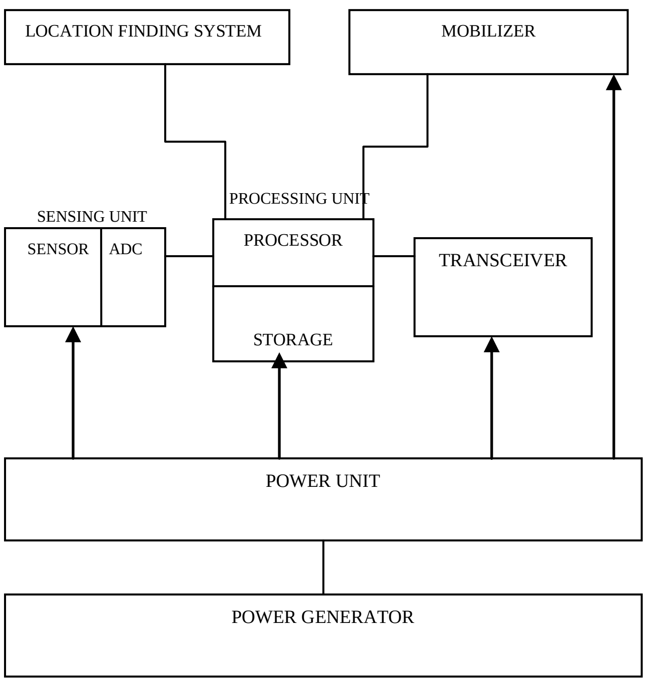


**Fig 2 : Components of a Sensor Node**

Sensor nodes consist of four component s: sensing unit, processing unit, transceiver and power unit. They also have additional components which are application dependent such as location finding system, mobilizer and power generator. A sensing unit usually has two subunits. The transceiver forms the connection between the nodes in the network to the central network. Another important component of a sensor node, the Power unit, is provided with power by scavenging units such as the solar cells. Every sensor network depend s on its subnets and router techniques for data transmission. The practice of dividing single network into two or more networks is called subnetting and the networks created by such a process are known as sub-networks or subnets. Routers are devices that forward data packets to and fro networks thus creating an internetwork or internet. A router is typically connected with different networks. When a data packet comes in from one of these networks for transmission, the router read s the information in the packet to determine the destination address. Every router has within, a routing table or routing policy, with which it directs the packet to the next network.

## 3. DECOMPOSITION OF A NETWORK

The numerous small powered nodes present in the wireless sensor networks require undistributed environment for proper operation. To maintain the lifetime of the sensors it is necessary to save the limited energy provided while performing the sensor operations. But the disadvantage with the wireless sensor networks is its huge energy consumption, and hence leading to the reduction in the lifetime of the network. This leads to the fact that in order to increase the node lifetime, the most effective approach would be to reduce the power consumption during communication between nodes from the same and different networks. Two strategies, generally in use, for energy dissipation in sensor communication are, to adjust the radio transmission power of each node and scheduling of the wireless interfaces of the nodes to rotate between active and sleeping status. All these proposed models have not failed to maintain the network connectivity while minimizing the energy consumption. Despite, all these measures to reduce the energy consumption, energy is still wasted in the form of idle listening by the nodes instead of packet transmission and reception in a dense network as a whole. Hence, an effective approach would be to segregate the idle and active nodes and grouping them to form a cluster of nodes having similar activities to be performed at the moment. According to the sleep scheduling approach it is proposed that energy consumption can be reduced without causing delay in data delivery as only few sensors will be used in the data transmission and reception. Fig. 3 shows the general communication network.

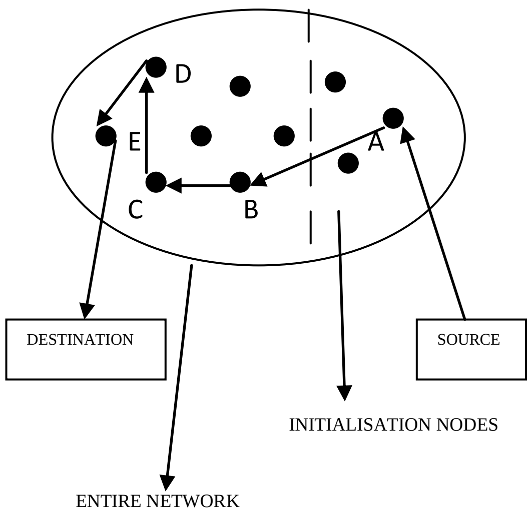


**Fig 3 : General Communication of a Sensor Network**

In this paper, we propose that the few sensors that are in the active or listening mode can be segregated from the rest of the network allowing them to form a sub-network within the network. The remaining idle sensor nodes can also be separated into clusters with distinct functionalities. The cluster can also be formed based upon the energy consumption required for each operation in the network for a successful data transmission. Hence subnets that are not required for a particular data transfer operation remain undisturbed in their idle state while energy is distributed in different proportions to the remaining networks. Regardless of the selected nodes, all the active nodes are needed to form a connected backbone network which encompasses all he subnets to form a whole network. This method of combining the subnets that are separated from a network can enhance and prolong the longevity of a network as energy consumption is considerable reduced. Fig. 4 shows the decomposition of the network in Fig. 3 along with its subnets as an entire network. The subnets A, D and E are active while subnet B is idle during the transmission between the source and destination. The nodes in the subnet A are the initialization nodes of the transmission. As nodes in the subnet B do not take part in the transmission, no energy is dissipated to this subnet hence reducing the amount of energy consumed by the network as a whole.

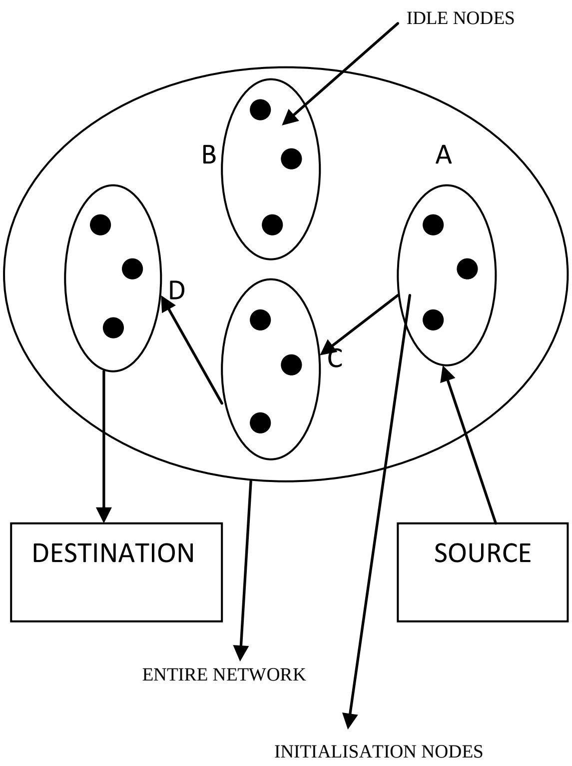


**Fig 4 : Simplified Network with active and idle subnets**

## 4. NETWORK SURVIVABILITY

Survivability refers to the ability of a network to comply with the requirements of the data to be transmitted even during the presence of failures. A network component or subsystem failure should, in no way, affect the users of the system, the impairment being caused by any attack, accident or failure. The management and design of the wireless sensor network should be in such a way that it is able to handle unexpected node failures and in case of its occurrence the network should be provided with a self – recovery mechanism. In a wireless sensor network, the widespread distribution of the sensor nodes lead to data transmission loads causing the problem of energy hole. The energy hole is a problem in which the energy of the nodes in the hole region tend to get used up faster than the energy of the nodes in the other regions. This is a critical factor which affects the lifetime of the networks. The transmission ranges for the nodes in a sensor network also determine network lifetime apart from the energy intake. This is done at the time of node deployment.

We can perform the same in the case of the sub-networks. Apart from decomposing the sub – networks based on their energy consumption state of operation, they can also be divided according to the transmission ranges which can be grouped within the same network. A centralized and distributed algorithm is in current use for assigning the transmission ranges for sensors in different node distribution. But the assignment of transmission ranges to sensors in networks, where they are grouped along with energy reducing nodes is a challenging process. An algorithm for this condition has to be designed in such a way that it not only assigns transmission ranges, but is also, able to identify the energy reducing nodes, from the nodes for which it has to assign the transmission ranges. This method of assigning the transmission ranges to sensors within the network renders it possible to analyze whether a particular node can perform the data transmission successfully or will result in a failure. This analysis further helps to decide whether the deployed node will operate only in certain conditions or for all user required conditions. By this analysis inefficient sensor nodes and networks can be removed and nodes that are completely analyzed for operation under any circumstances can be deployed offering better service.

## 5. CONCLUSION

The idea of decomposition of the network into sub networks presented in this paper, if implemented, by the use of algorithms that optimize energy while breaking the network into its subnets would help increase the current network survivability and make the wireless sensor network operate without compromising its Quality of Service in the transmission of its data.

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