International Journal of Scientific & Engineering Research, Volume 3, Issue 6, June-2012
ISSN 2229-5518


# Global Catastrophic Alert System

Silica Kole

**Abstract**— Global Catastrophic Alert System is a pre-alert system for disasters like Earthquake and Tsunamis consisting of a heterogeneous network of Sensor chips. This is a sensor network which can be laid out in an Earthquake prone area and can be used to predict approaching Earthquakes. The sensor chips used in this system would vary in their processing prowess, storage capacity and power consumption. The sensor chips would be spread along a circular perimeter over the Earthquake or Tsunami prone area in such a way that the peripheral sensor chips would be of the most basic quality consuming very less power. As we move towards the centre of this circular perimeter the sensor chips would become more sophisticated. The centre of this perimeter would consist of a base station or a mother server controlling the received signals of all the surrounding chips and takes decisions in spreading out alerts.

**Index Terms**— Alerts, Accumulated Potential Energy, Earthquakes predictions, Heterogenous sensors, Sensors, Simulation, Wireless Sensor Networks

## 1 Introduction

A heterogeneous sensor network can consist of a variety of compositions of sensors (like sensing ability, power consumption, reusability etc.). I am considering the sensors in my proposed network to vary in power consumption and reusability only. [5]

The sensor chips (the peripheral layers in the proposed network) would be situated in the turbulent or Earthquake susceptible zones, so there would be very high chances of wipe out or loss of these chips. Hence these sensor chips would be of low quality or low cost with no processing power and memory. Processing unit and memory consumes much of the power of a sensor chip which runs on a lithium ion cell or solar power or both. Though as we move towards the inner circles of the network, processing power and memory gradually increases in the sensor chips.

Sensors would sense tremors, strain energy accumulated in Earth and temperature of surrounding air. The flow of signals would be from outer circle to inner circle ending at the base station. Peripheral layers of sensors would just sense and forward signals, inner sophisticated layers of sensors would show some discretion in forwarding the signals. The inner layers of sensors would process the signal as critical or non-critical, if critical then the signal is forwarded and if non-critical, then the signal is stored for some definite time. The sensor network being considered here is to be time driven.

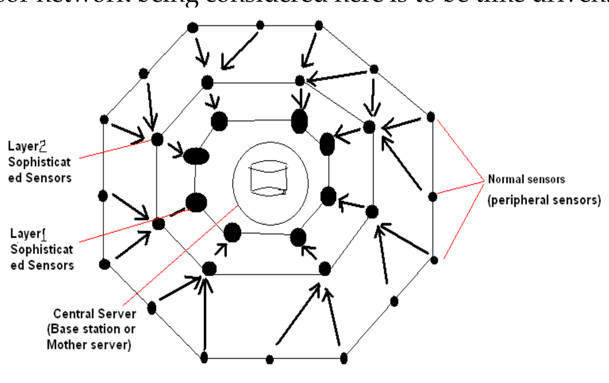


Fig.1. Proposed Heterogeneous Wireless Sensor Network

## 2 Review of Literature

### 2.1 *Earthquake*

An earthquake (also known as a quake, tremor or temblor) is the result of a sudden release of energy in the Earth's crust that creates seismic waves. The seismicity or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time. Earthquakes are measured using observations from seismometers. The moment magnitude is the most common scale on which earthquakes larger than approximately 5 are reported for the entire globe. The more numerous earthquakes smaller than magnitude 5 reported by national seismological observatories are measured mostly on the local magnitude scale, also referred to as the Richter scale. These two scales are numerically similar over their range of validity. Magnitude 3 or lower earthquakes are mostly almost imperceptible and magnitude 7 and over potentially causes serious damage over large areas, depending on their depth. The largest earthquakes in historic times have been of magnitude slightly over 9, although there is no limit to the possible magnitude. The most recent large earthquake of magnitude 9.0 or larger was a 9.0 magnitude earthquake in Japan in 2011 (as of March 2011), and it was the largest Japanese earthquake since records began. Intensity of shaking is measured on the modified Mercalli scale. The shallower an earthquake, the more damage to structures it causes, all else being equal. [1]

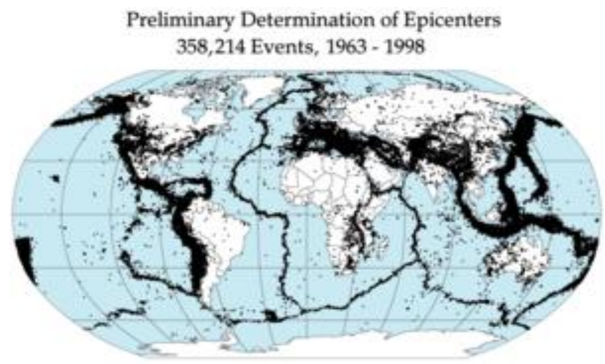


Fig.2.Epicenters of the Earth 1963-1998 [1]

### 2.2 *Sensor Network*

A sensor network is composed of a large number of sensor nodes, which are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need not be engineered or pre-determined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities. Another unique feature of sensor networks is the cooperative effort of sensor nodes. Sensor nodes are fitted with an on-board processor. Instead of sending the raw data to the nodes responsible for the fusion, sensor nodes use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data. The above described features ensure a wide range of applications for sensor networks. Some of the application areas are health, military, and security. For example, the physiological data about a patient can be monitored remotely by a doctor. While this is more convenient for the patient, it also allows the doctor to better understand the patient's current condition. Sensor networks can also be used to detect foreign chemical agents in the air and the water. They can help to identify the type, concentration, and location of pollutants. In essence, sensor networks will provide the end user with intelligence and a better understanding of the environment. We envision that, in future, wireless sensor networks will be an integral part of our lives, more so than the present-day personal computers. Realization of these and other sensor network applications require wireless ad hoc networking techniques. Although many protocols and algorithms have been proposed for traditional wireless ad hoc networks, they are not well suited for the unique features and application requirements of sensor networks. [2][3]

## 3 Construction of the Global Catastrophic Alert System

In the physical world if this network is implemented the sensors should be air dropped on an earthquake prone area which can be some unapproachable place. The sensors should be placed in the proposed way covering a specific perimeter.
As can be seen in the Figure 1 there are three distinct layers of sensors: peripheral sensors, layer 2 sensors and layer 1 sensors. The peripheral sensors would sense or calculate accumulated potential energy of the nearby earth for say about 6 hours (since the sensors are time driven), then they would forward this data to the next layer. The peripheral layers would not possess any sort of memory; their function is to just sense and send data. Accumulated Potential Energy will use the formulae mxgxh in which 'm' (i.e. mass) and 'h' (i.e. depth) will vary and g (i.e. acceleration due to gravity) will remain constant i.e. $9.8m/s^2$ , 'h' will vary between 0-80 km depth since it has been observed by seismologists that most earthquakes generate from within a depth of 0-80 km, 'm' will vary according to the bulk density of the soil of the Eartquake prone area and more the depth taken into account more the mass considered. Different peripheral sensors will sense different values of 'm' and 'h' and forward it to the next layer where the 'mxgxh' will get calculated and an average Accumulated Potential Energy gets generated.

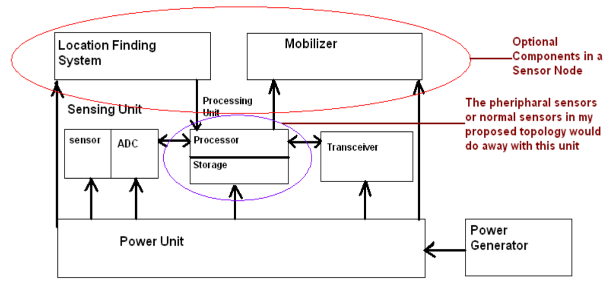


Fig.3.The components of a sensor node [2]

The layer 2 sensors would possess memory of some amount, as soon as they receive data from the peripheral sensors; they would determine whether the data is critical (high accumulated potential energy) or non-critical (low accumulated potential energy) against a previously set value of maximum Accumulated Potential Energy after which an earthquake happens, if critical the data would be forwarded to the next layer i.e. layer 1 and if non- critical the data is stored for some duration in the sensors' internal memory.
The layer 1 sensors would be similar to the layer 2 sensors but with more memory than the layer 2 sensors and less in numbers than the layer 2 sensors. They would also determine the criticality of the received data and if data is critical it would be forwarded to the base station and if not critical, it gets stored for some duration in the sensors' internal memory.
The base station would forward the critical data along with an Earthquake approaching alert summary to the nearest Government facilities and Satellite stations which would then generate pre-Earthquake alerts through live media or telecommunication systems.

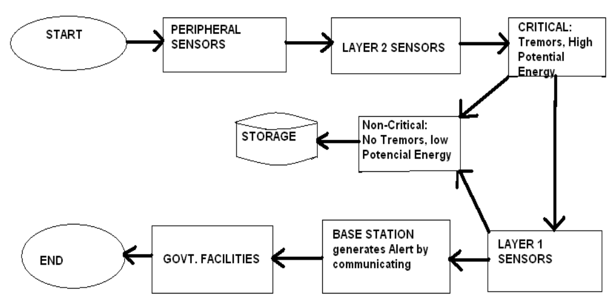


Fig.4. Data flow diagram of the working of the proposed network

## 4 Justification and Likely Benefits of the Global

### CATASTROPHIC ALERT SYSTEM

Earthquakes can hit any place anytime, that place may be a populated area or in the middle of an ocean which can then result in a massive Tsunami. In the absence of an Earthquake Pre-alert System, the consequences can be severe i.e. loss of numerous human lives and property. For example the massive tsunami triggered by an Earthquake in the middle of the Pacific Ocean hit Japan in early 2011 causing colossal destruction, loss of lives and triggering a nuclear emergency as well. Implementation of Global Catastrophic Alert System using energy efficient Heterogeneous Wireless Network can help in saving a large number of human lives if pre-alerts of an approaching Earthquake can reach the common people in due time. The government facilities can help the people to evacuate safely before the catastrophe hits. The central server of the proposed Heterogeneous system can make direct Satellite communication, through the satellites various government and private rescue facilities can be alerted and evacuation missions can be carried out before the Earthquake hits.

## 5 IMPLEMENTATION

At this level physical implemention of the proposed network is not possible so the working of the Global Catastrophic Alert system has been represented in the form of a proxy simulation using MATLAB programming and in VB.Net platform. [6]

## 6 LIMITATIONS OF THE PROPOSED NETWORK

Current time earthquake sensors measure the displacement of earth after the earthquake has already taken placed; whereas in order to implement the proposed design such sensors are needed which can measure the Accumulated Potential Energy of the earthquake before the occurrence of earthquake.

There is always a possibility of false alarms like say an alert has been generated that an massive Earthquake is approaching and people are dislocated according to the pre-alert and then after the predicted time of occurrence of the earthquake if nothing happens, it would be loss of finance and effort both on people’s and Government’s part.

Fool proof prediction of a particular time of occurrence is yet not possible.

Power consumption of the sensors measuring accumulated potential energy could become a concern.

Replacing the sensors when they stop transmitting data can be a tough task.

## 7 CONCLUSIONS

The proposed Global Catastrophic Alert system can be a useful innovation using the advancements in the field of sensor technology. If a well researched form of such a system is implemented in the physical world, loss of lives can be prevented caused due to un-predictable natural calamities like Earthquakes and Tsunamis.

## ACKNOWLEDGMENT

Firstly I would like to thank my college for giving me the opportunity to conduct research on a project like this. Secondly I would like to thank my teachers for helping me in my initial preparation for taking up a research topic which shaped according to my expectations.

## REFERENCES

[1] Earthquake, from Wikipedia, the free encyclopedia, April 2011
[2] Sensor, from Wikipedia, the free encyclopedia, March 2009
[3] I.F. Akyildiz, W. Su*, Y. Sankarasubramaniam, E. Cayirci, Wireless Sensr Networks: A Survey, Computer Networks 38 (2002) 393–422
[4] Steven Kosmerchock, Wireless Sensor Netwoks Topologies, steve@stevekos.com, www.stevekos.com
[5] Enrique J. Duarte-Melo, Mingyan Liu, Analysis of Energy Consumption and Lifetime of Heterogeneous Wireless Sensor Networks, EECS, University of Michigan, Ann Arbor, ANI-0112801
[6] Computer Simulation, from Wikipedia, the free encyclopedia, May 2008
[7] Richter Magnitude Scale, from Wikipedia, the free encyclopedia, March 2005
[8] Sartaj Sahni and Xiaochun Xu, Algorithms For Wireless Sensor Networks, University of Florida, Gainesville, FL 32611, {sahni,xxu}@cise.ufl.edu, September 7, 2004

• *Silica Kole is currently pursuing M.Tech degree program in Computer Science & Engineering at Institute of Engineering & Technology, MIA, Alwar, Rajasthan, India. E-mail: silica_kole@yahoo.com*