International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 06 | June-2016 www.irjet.net p-ISSN: 2395-0072

The Wireless Sensor Networks: Smart Dust

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Abstract- *Smart Dust is an upcoming technology made up of tiny, wireless sensors which are also called MOTES. The devices are smart enough to talk with other sensors which are small to adjust on the head of a pin. These are light in weight that they can be placed in the environment like any ordinary dust particle. A Smart dust is a Millimeter-scale self-contained microelectromechanical sensor (MEMS) devices which include sensors of the ability of computing with bi-directional wireless communications technology and a power supply. The tiny dust particles, smart dust sensors can be spread throughout buildings or into the atmosphere to collect and maintain data. Smart dust devices have applications in everything from military, microbiological and medical fields.*

Keywords: SmartDust ,microelectromechanical sensor(MEMS),bi-directionalwireless communications technology, military, microbiological, medical fields.

1. INTRODUCTION

The "Smart dust" devices are small wireless microelectromechanical sensors (MEMS), these are used to sense everything from environment. The silicon and fabrication techniques, the "MOTES" are the size of a grain like sand; each of the grain particles contains sensors, computing circuits, and bidirectional wireless communications technology with a power supply system [1]. MOTES will gather the data and perform computations and communicate the information with adjacent MOTES using two-way band radio signals. The MOTES communicate with one other at approximately 1,000 feet of distance.

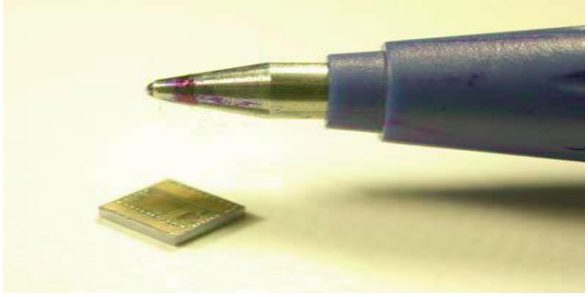

Fig -1: The Size of the Smart dust

Smart dust is a technology of a tiny wireless sensor network, which are made of microelectromechanical sensors (called MEMS). The robots, usually works with sensors, which have self-contained sensing, computation ability, communication with devices and power supply system. The new technology is formed the combination of nano technology, wireless sensor technology and microelectromechanical system called Smart dust. These sensors are nano sized called motes. The collective Smart dust sensors are placed in the environment to gather the data[2]. These devices primarily developed for the battle place later this technology has spread in several media.
The Defense Advanced Research Projects Agency (DARPA) has been funding Smart Dust research since the 1990s. Smart dust has limitless applications in the sphere of modern warfare. So far the research has been capable with prototype smart dust sensors as small as 5mm.But further scaling down needs advance technological changes [3]. Costs have been dropping rapidly with technological innovations, bringing individual motes down to as little as $50 each, with hopes of dropping below $1 per mote in the future.

2. SMART DUST ARCHITECTURE

The Smart dust mote structure is shown in Figure2.A single pack of microelectromechanical sensors (MEMS) is a semiconductor laser diode and microelectromechanical beam for active optical transmission. A MEMS corner-cube retro-reflector used for passive optical transmission and an optical receiver for signal processing and is to control circuitry and a power source based on thick-film batteries and solar cells. This package will have the ability to sense and communicate and compute with other sensors that are to be self-powered.

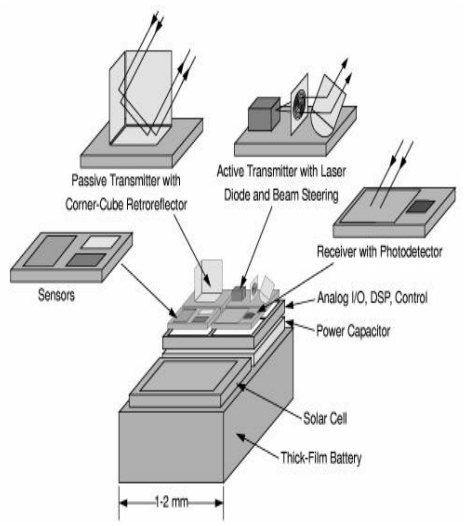

Fig -2: Architecture of Smart dust

A major activity is to collect all these functions and maintaining with very low power consumption, then maximizing the life of mote in the limited volume available for energy storage. In the design goal of a cubic millimeter volume, using the best available battery equipment, the total stored energy is on average of 1 J. If this energy is consumed continuously over one day, the smart dust mote power consumption cannot exceed approximately 10W. This is termed as "Shutdown power" of individual low power Integrated Circuits (ICs) found in recent computers. The functionality for Smart dust can be achieved only if the total power consumption of a smart dust mote is not exceed to microwatt levels, when normal power management strategies are used. To enable dust mote to activate over some period of days, then the solar cells could be working to search as much energy as possible when the sun shines (roughly 1 J per day).

The topological structure of wireless networks is shown in figure 3. Mesh topology and hub-and-spoke topology is used in the development of this network. In the mesh topology, each mote acts like an independent instrument, where as in hub-and-spoke one of the motes acts as cleaning house for all data network, i.e. the stored old data has been deleted after sending to the nearest subsystem. Each mote gathers nearest data and sends it to the adjacent motes.

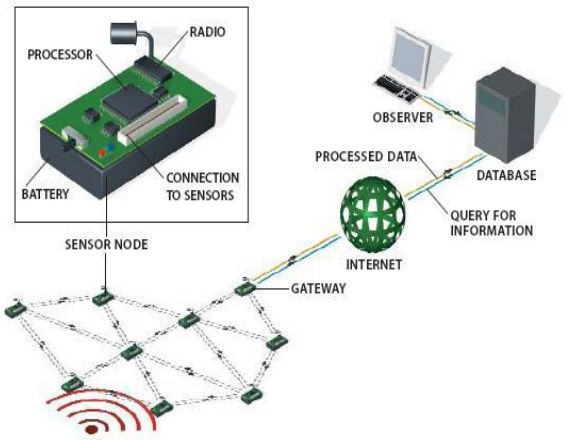

Fig -3: Topology of wireless sensor network

There are some issues in topology of wireless sensor networks which has overcome by different parts of the motes. The Power availability of the mote is limited which limits the efficiency of sensor networks. Scientists are developing the protocol to reduce the power consumption of motes. The sleep-awake protocol is used to detect sudden changes in data noted by the motes [4]. The sleep-awake protocol is activates once in a second. The time duration will be 0.05 millisecond per each note. In every 10 millisecond the data will be exchanged with neighbor motes [5]. While exchanging data, the motes did not consume power. GPS will be used to spread data from mote to mote as well as mote to the nearest subsystem.

3. WORKING OF SMART DUST

The mote is one of the emerging sensor computing techniques. The mote is a small computer which having low power and low cost. One computer examines one or more sensors. The sensing applications are common to the motes such as to sense temperature, light, sound, position, acceleration, stress, vibration, humidity, etc. The computer connects with radio link to monitor sensors. The radio link transmits the sensing power from 10 feet to 200 feet distance [6]. Because of small size, the motes having normal radios power. The motes run on batteries and some works with power grid in some applications. If the motes are very small to maintain batteries, in such cases it will work on solar power.

Fig -4: Smart dust internal structure

4. SMART DUST IN COMMUNICATION SYSTEM

RAND (Research and Development Corporation) developed microelectromechanical devices which are sensors. These devices are having the ability of communication and computing technique. These are the tiny devices like dust which works like sensors. This technology is introduced in the starting of 1991's. These sensors are used to collect the data and send it to the connected mentor devices. These devices are placed in atmosphere to collect the moments in the environment.

The Smart dust is mostly used in agriculture, medical, communications systems. MEMS (microelectromechanical) are the smallest devices which are placed in the target positions. I.e the Smart dust devices are thrown in the fields to collect data. The group of MEMS are connected to a remote system. MEMS collect the data and send it to mentor system. The communication subsystems (mentor systems) are responsible to exchange and maintain data.

5. SMART DUST IN FUTURE

The Smart dust is size of cubic millimeter, which contains power, communications and computations. According to many researches"Smart dust will be one of the essential techniques in future". Large industries like GE General Electric and Cargill and Emerson Electric are investing in the development of Smart dust. IBM, CSCO are funding for technical improvement of this technology [7]. The first generation Smart dust products are about to hit the market. These sensors used to monitor buildings, power pipelines, medical, and security systems [8]. The technology of smart dust is based on optical and fiber-optic communications. The microelectromechanical sensors are one of the main technologies which can improve communication and optical system [9]. The smart dust can raise a revelatory change in coming decades in communication system because of its small sensors. It also needs less maintenance. With the usage of smart dust the complex functions becomes easy.

6. LIMITATIONS

- The Major disadvantage of Smart dust is privacy. This technology notes every small change in the environment, it may harmful to adopt in every situation.
- The limitation is cost. It is still developing technology; because of this the price is comparatively high.
- Sensor nodes are randomly deployed and don't follow any standard rules. The random sensors makes weak for unusual topology [10]. There will be no special maintenance to the sensors once installed.
- There is no special frame work to the sensors. So that it is easy to route every routing algorithm so tracking of the sensors become very easy and it leads to security issues.
- The sensors works on battery power, the availability of the power is limited and difficult to replace battery often.

7. CONCLUSION

Smart dust is an emerging technology; many researches are going on to make it available with low price and small size. The cubic millimeter sensing nodes, which are capable of bidirectional communication? The components of the smart dust are to gather and maintain the data. The optical devices to sense the data and electrical equipments to transfer data to adjacent devices. The smart dust mote designing to minimize the power usage and maximize the capability to accesses the data. Every mote is capable to communicate with other and transfer the information to nearest subsystem. In this paper we discussed about how the motes will communicate and transfer the information from one sensor to another.

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