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An Optimal Sensing as a Service Algorithm in Wireless Sensor Networks for IoT

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***Abstract*--** **The recent trends in wireless communication has let the researchers to focus on the variety of technologies. Wireless Sensor Networks and Internet of Things are one amongst the many kinds of application oriented technologies. These kinds of technologies are connected using a wireless network with a variety of objects having limited resources. As wireless sensor networks play a major role in providing sensing as a service, it can be remotely accessed by Internet of things. Thus, it lets us focus on power optimization in sensor networks for efficient data transmission purposes using Internet. This research work helps to optimize the power consumption in sensor networks for Internet of things using a clustering technique with mobile sink node.**

***Keywords*—** Wireless Sensor Networks, Internet of things, Power Optimization, Clustering, Google Balloon

I.INTRODUCTION

In recent years, Wireless Sensor Networks (WSNs) has attracted a lot of attention from researchers in both academic and industrial communities. A WSN consists of a collection of sensor nodes and a base station connected through wireless channels, and can be used for many applications such as military application, building distributed systems, physical environment monitoring, and security surveillance among others. An advantage of sensor networks is the ease of deployment, reducing installation cost, possibility to distribute the tiny sensors over a wide region, and larger fault tolerance[1][2][3].

Internet of Things (IoT) [4] is comprised of smart machines interacting and communicating with other machines, objects, environments and infrastructures. As a result, huge volumes of data are being generated, and that data is being processed into useful actions that can "command and control" things to make our lives much easier and safer. These features of data collection lead the usage of WSNs and make it available through Internet. Features of IoT: IPv6, Open Standard, Widespread, Scalable, Auto-configuration, Simple.

It is the new era[5] that allows a connection between the virtual and the real world in such a way that it links every object in the real world with the virtual world. IoT world builds an interaction between all physical objects such as people, cars, tables, chairs, etc., in such a way that one can define each of them in the virtual world and enable connectivity between all of them anywhere and anytime. IoT can be applied in many applications such as aerospace, supply chain, telecommunications. There are some technologies that enable that connection such as Radio Frequency Identification (RFID) and Wireless Sensor Network (WSN).Merging both of these technologies can make the revolutions of the IoT real world.

WSNs the Building Block of IoT:

The types of sensing nodes needed for the IoT varies widely depending on the applications involved. Sensing nodes could include a camera system for image monitoring; water or gas flow meters for smart energy; radar vision when active safety is needed; RFID readers sensing the presence of an object or person; doors and locks with open/close circuits that indicate a building intrusion; or a simple thermometer measuring temperature. The bottom line is that there could be many different types of sensing nodes, depending on the applications. These nodes will all carry a unique ID and can be controlled separately via a remote command and control topology. Use cases exist today in which a Smartphone with RFID and NFC and GPS functionality can approach individual RFID/NFC-enabled "things" in a building, communicate with them and register their physical locations on the network. Hence, RFID and NFC will have a place in remote registration, and, ultimately, command and control of the IoT.

*Google Balloon[6]:*In recent years, military and aeronautical researchers have used tethered balloons to beam Internet signals. Google's balloons would be untethered and out of sight, strung out in a line around the globe. They would fly in the air around the globe.

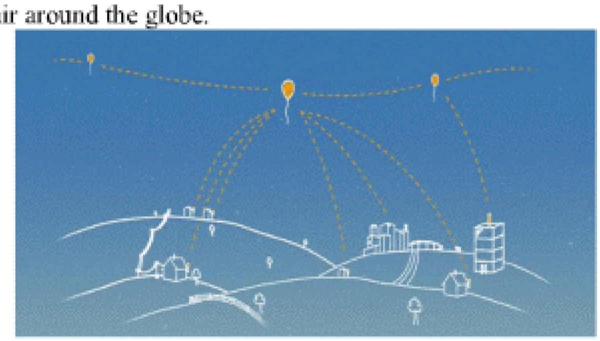

Fig-1:*Sensor Collecting Data Google Balloon*

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II.RELATED WORK

The section focuses on the existing mechanism in WSNs for optimal communications with the recent trends, architecture and application of Internet of Things.

A. Efficient Clustering Mechanism in WSNs

LEACH[7]: Initially, when clusters are being created, each node decides whether or not to become a cluster-head for the current round. This decision is based on the suggested percentage of cluster heads for the network (determined a priori) and the number of times the node has been a cluster-head so far. This decision is made by the node n ,choosing a random number between 0 and 1, if the number is less than a threshold T(n), the node becomes a cluster-head for the current round. The threshold is set as:

$$T(n) = \begin{cases} \dfrac{P}{1 - p(r \bmod (1/p))} & n \in G \\ 0 & others \end{cases}$$

Where P = the desired percentage of cluster heads (e.g. P = 0:05), r = the current round, and G is the set of nodes that have not been cluster-heads in the last 1/P rounds. Using this threshold, each node will be a cluster-head at some point within 1/P rounds. During round 0 (r = 0), each node has a probability P of becoming a cluster-head. The nodes that are cluster-heads in round 0 cannot be cluster-heads for the next 1/P rounds. Thus, the probability that the remaining nodes are cluster-heads must be increased, since there are fewer nodes that are eligible to become cluster-heads. After 1/P- 1 rounds, T = 1 for any nodes that have not yet been cluster-heads, and after 1/P rounds, all nodes are once again eligible to become cluster-heads.

HEED [8]:In this they are taking two parameters, the clustering process interval, TCP, as the time taken by the clustering protocol to cluster the network and the network operation interval, TNO, as the time between the end of a TCP interval and the start of the subsequent TCP interval, with TNO > TCP to reduce overhead. Clustering is triggered every TCP +TNO seconds to select new cluster heads. At each node, the clustering process requires a number of iterations, which we refer to as N_{iter}. Every step takes time tc, which should be long enough to receive messages from any neighbour within the cluster range. We set an initial percentage of cluster heads among all N nodes, C_{prob}(say 5%), assuming that an optimal percentage cannot be computed apriori. C_{prob} is only used to limit the initial cluster head announcements, and has no direct impact on the final clusters. Before a node starts executing HEED, it sets its probability of becoming a cluster-head, CH_{prob}, as follows:

$$CH_{prob} = C_{prob} \times \frac{E_{residual}}{E_{max}}$$

where $E_{residual}$ is the estimated current residual energy in the node, and E_{max} is a reference maximum energy (corresponding to a fully charged battery), which is typically identical for all nodes. The CH_{prob} value of a node, however, is not allowed to fall below a certain threshold p_{min} (e.g., 10^-4), that is selected to be inversely proportional to E_{ma}. This restriction is essential for terminating the algorithm in N_{iter}= **O**(1) iterations

B. Internet of things

The future Internet, designed as an "Internet of Things" is foreseen to be "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols". Identified by a unique address, any object including computers, sensors, or mobile phones will be able to dynamically join the network, collaborate and cooperate efficiently to achieve different tasks. Including WSNs in such a scenario will open new perspectives. Covering a wide application field, WSNs can play an important role by collecting surrounding context and environment information.

Wireless sensor networks (WSNs) are increasingly gaining impact in our day to day lives. They are finding a wide range of applications in various domains, including health-care, assisted and enhanced-living scenarios, industrial and production monitoring, control networks, and many other fields. In future, WSNs are expected to be integrated into the "Internet of Things", where sensor nodes join the Internet dynamically, and use it to collaborate and accomplish their tasks. However, when WSNs become a part of the Internet, we must carefully investigate and analyze the issues involved with this integration.

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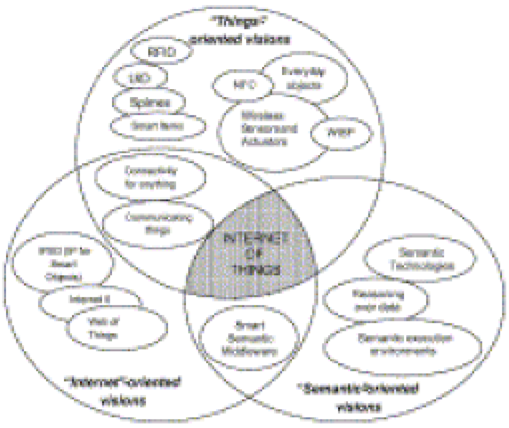

Fig 2: "Internet of Things" paradigm as a result of the convergence of different visions.

III.PROPOSED WORK

WSNs have a fixed infrastructure that is responsible for collecting the data from the sensors that are deployed in human unattended area. This work aims to develop an efficient clustering algorithm for providing sensing as a service through IoT using a mobile infrastructure. The mobile infrastructure may be any air vehicles like google balloon, drones.

The proposed algorithm aims to cluster a group of nodes in the network and transmit the collected information to base station. In this work they are two base station mobile and static, the selected cluster head will send the information to the nearest base station. Later, these bases station will exchange their information.

A. Criteria for becoming a Cluster Head

As all the nodes in WSNs are homogeneous it is difficult to select the nodes as cluster head (CH), hence at the beginning of the communication some nodes are randomly selected as CH using the below equation, Threshold number T(n) .

$$T(n) = \begin{cases} \dfrac{P/r}{1 - p(r \bmod (1/p))} & n \in G \\ 0 & others \end{cases}$$

In the next rounds all nodes have dissipated some amount of energy. At this point cluster head must have some minimum amount of energy so that it can transmit the packet successfully to the base station. So, we are calculating the threshold distance and the threshold energy for the node to become cluster head. Only the node which is selected randomly which is satisfying this threshold energy distance condition will act as the cluster head. Equation below gives the threshold distance and energy:

$$M_{\varepsilon} = (\varepsilon_{tx} * \varepsilon_{da}) * k + \varepsilon_{fs} * k(T_d * T_d)$$

Where,

$T_d = \sqrt{M_d^2 + M_d^2}$ = Threshold distance

$M_d = \dfrac{a}{400}$

Where a= area of a Square network

ε_{tx}= Transmitting energy.

ε_{da}= Data Aggregation Energy

k=Packet size

B. *Data Transmission*

Data transmission from Cluster Head to Sink:

In this architecture, each CH will collect the data from the members and aggregate the data and send it to its nearest base station which may be stationary or mobile.

Data transmission from nodes:

The sensor nodes which are members of the respective cluster will sense the data and send it to its nearest cluster. By this we can reduce the distance between the each node that communicate with each other. The TDMA protocol at the cluster head will schedule when the node must send the data to it, by that time all nodes will be in sleep state by consuming less energy.

IV.RESULTS

Figure below shows the deployment of the network, the yellow coloured nodes are the cluster head and green nodes are the member associated with clusters. The cluster communication with base station is given in pink and red coloured lines, where pink colour represents the mobile station and red for static. The black line represents the communication between mobile and static sink node.

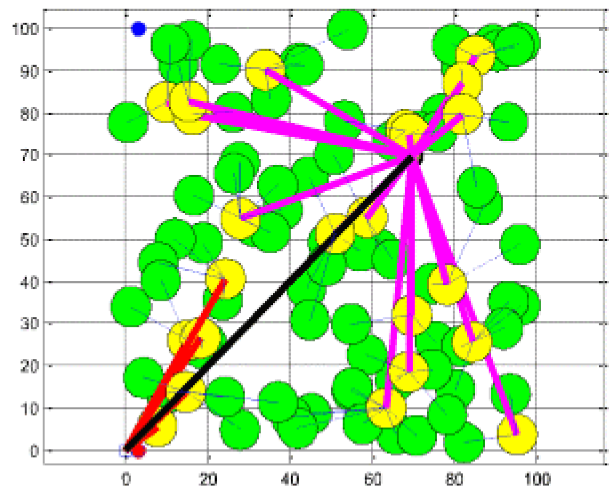

Fig-3: *Network Model*

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Figure below shows the comparison lifetime of the network and proposed clustering algorithm for providing good sensing as a service. This results shows that the proposed algorithm is 25% efficient than the existing one when using mobile base station

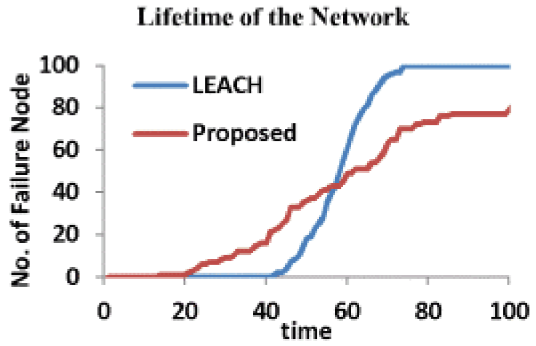

Fig-4:*Lifetime of the Network*

The parameters used for testing the proposed algorithm are shown in the below table.

Prameter	Value
Network grid	From (0,0) to (100,100)
Number of nodes	10
Sink	At (50,50)
Mobile Sink	Random Speed
Efs	10**pJ**
Emp	0.0013 **pJ**
Threshold distance( )	Efs/Emp
Initial Energy of each node	0.02 **J**
Data packet size	4000 **bits**
Data Aggregation Energy	**5nJ/bit**
Energy to Receive	50 **nJ/bit**
Energy to transmit	50 **nJ/bit**
Simulated for	100 **rounds**
Probability of becoming cluster head	0.5/100 nodes

Table-1: Simulation Parameters

V.CONCLUSION

Internet of things and wireless sensor networks are the recent application oriented technologies in wireless communication. As the technologies grow, the size of the device used for communication will be reduced which intum has limitation in resources, battery power is one of the major issue in resource utilization. This work proposed a novel idea for getting data from WSNs through IOT by efficient clustering using mobile sink. This efficient mechanism can reduce the power consumption in WSNs which are the major block in providing sensing as a service.

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