



## An Adaptive Technique for Data Propagation in Sensor Networks

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**Abstract** — *Micro Electro-Mechanical Systems (MEMS) have made in-situ sensing with wireless sensor networks (WSNs) a promising technique. As wireless integrated network sensors are powered with a small battery and they usually work in an unattended manner, the main constraint of a sensor node is that its energy resource is limited. To enable in-situ sensing, sensor nodes and WSNs should function in an energy-efficient manner. Energy optimization techniques must be performed in every level of the design of a sensor network system. The work described various aspects of power saving approaches to achieve energy-efficient and reliable WSNs. PORT, a Price-Oriented Reliable Transport protocol for wireless sensor networks to reliably and energy-efficiently convey sensor information to the sink. The problem of transmitter power control for energy-efficient sensor-to-sink communications. This model problem based on the network and application features of WSNs. An intuitive implementation to solve this problem, namely BOU (Broadcast-On-Update), is presented. It can be identify the broadcast explosion problem in BOU and then improve BOU by allowing a waiting period before each broadcasting. Such that the waiting time should be proportional to the probability that a node would find a more energy-efficient path to the sink and present an efficient approximation algorithm to calculate the probability. Sensor networks are collection of sensor nodes which cooperatively send sensed data to base station. As sensor nodes are battery driven, an efficient utilization of power is essential in order to use networks for long duration hence it is needed to reduce data traffic inside sensor networks, reduce amount of data that need to send to base station. Wireless sensor networks (WSN) offer an increasingly Sensor nodes need less power for processing as compared to transmitting data. It is preferable to do in network processing inside network and reduce packet size. One such approach is data aggregation which attractive method of data gathering in distributed system architectures and dynamic access via wireless connectivity. Wireless sensor networks have limited computational power and limited memory and battery power, this leads to increased complexity for application developers and often results in applications that are closely coupled with network protocols. Data aggregation framework on wireless sensor networks is presented. The framework works as a middleware for aggregating data measured by a number of nodes within a network. The main goal of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced.*

**Keywords** — *Micro Electro Mechanical System(MEMS), Wireless Sensor Network(WSN), Price Oriented Reliable Transport (PORT), Event-to-Sink Reliable Transport, Wireless Integrated Network Sensor, Broadcast-On-Update, Broadcast-On-Update With Approximation, Maximum Life Time Data Aggregation.*

### I. INTRODUCTION

#### 1.1 WIRELESS SENSOR NETWORKS

Sensor networks are the key to gathering the information needed by smart environments, whether in buildings, utilities, industrial, home, shipboard, transportation systems automation, or elsewhere. Recent terrorist and guerilla warfare countermeasures require distributed networks of sensors that can be deployed using, e.g. aircraft, and have self-organizing capabilities. In such applications, running wires or cabling is usually impractical. A sensor network is required that is fast and easy to install and maintain. In recent years, advances in Micro Electro-Mechanical Systems (MEMS) have made it possible to integrate signal processing environmental data sensing, and wireless communication modules in one single small circuit board. Such technological developments make small, low-cost, low-power devices capable of sensing the environmental/physical data, collecting and processing such data, and communicating with wireless technology, a reality. Such devices are referred as wireless integrated network sensors (WINS), or in short, sensor nodes.

#### 1.2 WIRELESS INTEGRATED NETWORK SENSORS

Typical implementations of sensor nodes include the  $\mu$ AMPS sensor nodes developed by Massachusetts Institute of Technology (MIT), the WINS sensor nodes developed by the University of California at Los Angeles (UCLA) and the MICA2 Mote sensor nodes developed by the University of California at Berkeley. A typical sensor node consists of the following units.

- A power supply unit, which consists of a small battery with DC-DC conversion to the appropriate voltages required by the electronic system of a sensor node.
- One or more physical sensors. Examples of sensors include thermo electrical sensors to measure environmental temperature, acoustic sensors to monitor the sounds of interest, infrared sensors to capture the existence of the objects of interest, and seismic sensors to measure earth vibrations.
- The types of sensors employed are determined by the applications of the in-situ sensing tasks.
- A/D convertor to convert the analog signals captured by a sensor to digital signals.
- A RF radio communication unit. Usually the transmitter power of the radio unit can be shifted to different levels.
- One or more microchip computer systems to process the digital signals from the A/D convertor, to control and monitor the behaviours of the sensor node, and to run other required software such as communication protocols.

### **1.3 NETWORKING THE SENSOR NODES**

Among the great research efforts people have put in to enable environmental sensing with in-situ sensor nodes, a very important issue is how to network such sensor nodes. As individual sensor nodes are with low sensing and processing capabilities due to their commonly low-cost implementation, networking of a large number of sensor nodes can enhance the amount, as well as the accuracy, of the information obtained by the sensor nodes.

In proposed implementations of environmental sensing with in-situ sensor nodes, a number of in-situ sensor nodes are deployed to collect data about some physical phenomena of interest. The sensor nodes form an ad hoc multi-hops wireless network through which the collected data are conveyed to collectors, *e.g.*, hand-held devices such as PDAs and laptop computers. Such data collectors are called sink nodes. Sinks are usually with higher computational capabilities and power. They might also be able to communicate with other computers, *e.g.*, they are connected to the internet. Sinks are where the outside world obtain the data from the sensor nodes and where the outside world control the behaviours of the sensor nodes. Such networks are referred as wireless sensor networks (WSNs).

### **1.4 DATA AGGREGATION**

More energy to transmit data over long distances so that a better technique is to have fewer nodes send data to the base station. These nodes called aggregator nodes and processes called data aggregation in wireless sensor network. The main goal of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced. Wireless sensor networks (WSN) offer an increasingly attractive method of data gathering in distributed system architectures.

#### **Flat Networks**

In flat networks, each sensor node plays the same role and is equipped with approximately the same battery power. such networks, data aggregation is accomplished by data centric routing where the sink usually transmits a query message to the sensors via flooding and sensors which have data matching the query send response messages back to the sink.

#### **Hierarchical Networks**

Hierarchical data aggregation involves data fusion at special nodes, which reduces the number of messages transmitted to the sink. This improves the energy efficiency of the network. There are many types of aggregation techniques are present some of them are listed below.

##### **Tree-Based Approach**

In the tree-based approach perform aggregation by constructing an aggregation tree, which could be a minimum spanning tree, rooted at sink and source nodes are considered as leaves. Each node has a parent node to forward its data. Flow of data starts from leaves nodes up to the sink and therein the aggregation done by parent nodes.

##### **Cluster-Based Approach**

In cluster-based approach, whole network is divided in to several clusters. Each cluster has a cluster-head which is selected among cluster members. Cluster-heads do the role of aggregator which aggregate data received from cluster members locally and then transmit the result to sink.

The architecture of the sensor network plays a vital role in the performance of different data aggregation protocols. In this section, we survey several data aggregation protocols which have specifically been designed for different network architectures.

### **1.5 DATA AGGREGATION APPROACHES**

All the communication and computation burden at the sink in flat network, that's why lot of energy is consumed. In the hierarchical network, In which data aggregation data has to be done at special nodes, with the help of these special node we can reduce the number of number of data packet transmitted to the sink. So with this network improves the energy efficiency of the whole network.

#### **Cluster-Based Networks for data aggregation**

Wireless sensor network is resource constraint that's why sensor cannot directly transmit data to the base station. In which all regular sensors can send data packet to a cluster head (local aggregator) which aggregates data packet from all the regular sensors in its cluster and sends the concise digest to the base station. With the help of the scheme we save the energy of the sensors. The cluster heads can communicate with the base station directly. LEACH is the cluster-based network and data-aggregation protocol Low-Energy Adaptive Clustering Hierarchy (LEACH). A first energy conserving cluster formation protocol. The LEACH protocol is distributed and all sensor nodes organize into clusters for data aggregation (fusion). In which cluster head in each cluster sends the aggregated (fused) data from some sensor node in its cluster to the base station. This reduces the total number of information that is send to the base station. The data fusion is performed periodically at the cluster heads. LEACH performs two phases, the setup phase and the steady-state phase. In the setup phase networks are organize into the clusters and the selection of cluster heads. The below figure steady-state phase involves data aggregation process has to be done at cluster heads and data transmission to the base station (sink). LEACH has some limitations. LEACH says that all sensors have a capability to act as a cluster head and perform data aggregation process. LEACH also assumes that nodes have data packet to transmit sporadically. In LEACH, all nodes have the same amount of energy capacity in each selection round, which is based on the assumption that being a cluster head results in same energy consumption for every node. LEACH-C improves the performance of LEACH by 20 to 40 percent in terms of the number of successful data gathering rounds.

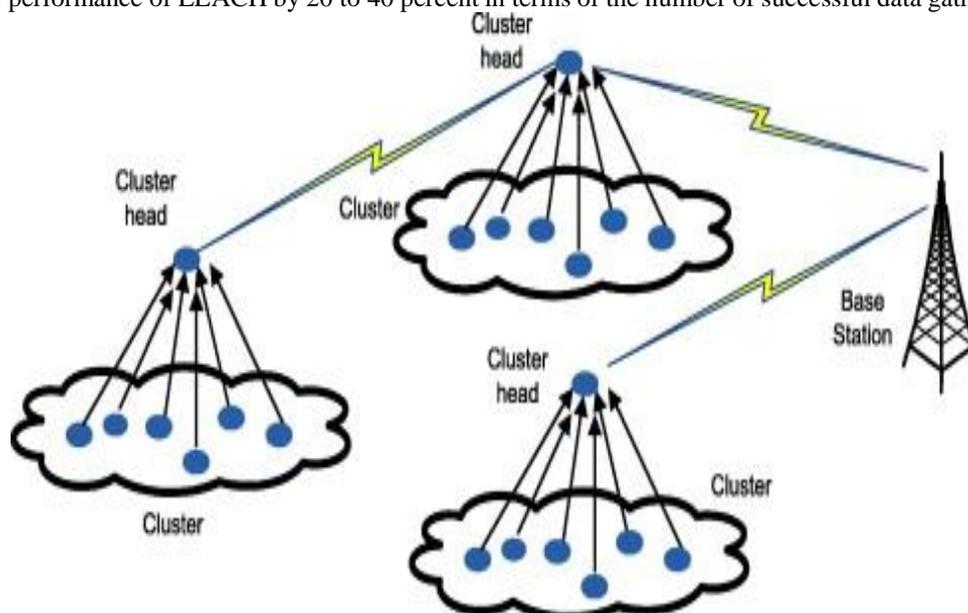


Fig 1.1 Cluster based sensor network

### Tree-Based Data Aggregation

All nodes are organized in form of tree means hierarchical, with the help of intermediate node we can perform data aggregation process and data transmit leaf node root node. Tree- based data aggregation is suitable for applications which involve in-network data aggregation. An example application is radiation-level monitoring in a nuclear plant where the maximum value provides the most useful information for the safety of the plant. One of the main aspects of tree-based networks is the construction of an energy efficient data-aggregation tree.

If the distribution phase, TAG organizes nodes in to a routing tree rooted at sink. The tree arrangement starts with broadcasting a data packet from base station specify level or distance from root. When a sensors gets this data packet it sets its own level to be the level of message plus one and select parent as sensor node from which it receives the data packet. After that, sensor node rebroadcast this message with its own level. This process continues until all nodes select their parent. After tree arrangement, sink send queries along structure to all nodes in the network. The tree can be reconstructed periodically from the sink. A sleeping sensor periodically wakes up and broadcasts hello message, which contains its path length to the sink. Each intermediate sensor receiving the interest must broadcast it at least once to setup the reverse path to the sink. The target sensor sends back the data along several paths.

## II. LITERATURE SURVEY

Jie Wu et.al [00] Wireless sensor networks constitute the platform of a broad range of applications related to national security, surveillance, military, health care, and environmental monitoring. The sensor coverage problem has received increased attention recently, being considerably driven by recent advances in affordable and efficient integrated electronic devices. The coverage concept is subject to a wide range of interpretations due to a variety of sensors and their applications. Different coverage formulations have been proposed, based on the subject to be covered (area versus discrete points) and sensor deployment mechanism (random versus deterministic) as well as on other wireless sensor network properties survey recent contributions addressing energy efficient coverage problems in the context of static wireless sensor networks [1].

Cardei et.al [02] A critical aspect of applications with wireless sensor networks is network lifetime. Battery-powered sensors are usable as long as they can communicate captured data to a processing node. Sensing and communications consume energy, therefore judicious power management and scheduling can effectively extend operational time. To monitor a set of targets with known locations when ground access in the monitored area is prohibited, one solution is to deploy the sensors remotely, from an aircraft. The loss of precise sensor placement would then be compensated by a large sensor population density in the drop zone that would improve the probability of target coverage. The data collected from the sensors is sent to a central node for processing. An efficient method to extend the sensor network operational time by organizing the sensors into a maximal number of disjoint set covers that are activated successively. Only the sensors from the current active set are responsible for monitoring all targets and for transmitting the collected data, while nodes from all other sets are in a low-energy sleep mode. It address the maximum disjoint set covers problem and we design a heuristic that computes the sets. Theoretical analysis and performance evaluation results are presented to verify our approach [2].

Yang fan Zhou [05] A point-distribution index  $t$ , which measures the normalized minimum distance between sensors. Maximizing  $t$  of a set of points causes the Delaunay triangulation graph of these points to be a net of equilateral triangles. Such a structure indicates the lowest redundancy of coverage if each point represents the center of a disc. Thus  $t$  can serve as a promising measure for solving a critical problem in field coverage: How to group a set of sensor nodes into disjoint subsets so that each subset can cover the entire field. Based on the  $t$  index, we develop an effective algorithm, MAXINE (MAXimizing- $t$  Node-redundancy Exploiting), for the sensor grouping problem. We evaluate the performance of MAXINE through extensive simulations and compare it with existing algorithms. The results demonstrate the effectiveness of MAXINE and verify the superiority of employing  $t$  for the sensor-grouping problem [3].

Fred Stan [03] Reliable data transport in wireless sensor networks is a multifaceted problem influenced by the physical, MAC, network, and transport layers. Because sensor networks are subject to strict resource constraints and are deployed by single organizations, they encourage revisiting traditional layering and are less bound by standardized placement of services such as reliability. To explore reliability at the transport layer, RMST (Reliable Multi-Segment Transport), a new transport layer for Directed Diffusion. RMST provides guaranteed delivery and fragmentation/reassembly for applications that require them. RMST is a selective NACK-based protocol that can be configured for in-network caching and repair [4].

Kemal Akkaya [03] Recent advances in wireless sensor networks have led to many new protocols specifically designed for sensor networks where energy awareness is an essential consideration. Most of the attention, however, has been given to the routing protocols since they might differ depending on the application and network architecture. This paper surveys recent routing protocols for sensor networks and presents a classification for the various approaches pursued. The three main categories explored in this paper are data-centric, hierarchical and location-based. Each routing protocol is described and discussed under the appropriate category. Moreover, protocols using contemporary methodologies such as network flow and quality of service modeling [5].

Su [01] The concept of sensor networks which has been made viable by the convergence of micro electro-mechanical systems technology, wireless communications and digital electronics. First, the sensing tasks and the potential sensor networks applications are explored, and a review of factors influencing the design of sensor networks is provided. Then, the communication architecture for sensor networks is outlined, and the algorithms and protocols developed for each layer in the literature are explored[6].

Jamal N. Al-Karaki [06] Wireless Sensor Networks (WSNs) consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specially designed for WSNs where energy awareness is an essential design issue. The focus to the routing protocols which might differ depending on the application and network architecture. A survey of the state-of-the-art routing techniques in WSNs. The design challenges for routing protocols in WSNs followed by a comprehensive survey of different routing techniques. Overall, the routing techniques are classified into three categories based on the underlying network structure: flat, hierarchical, and location-based routing. Furthermore, these protocols can be classified into multipath-based, query-based, negotiation-based, QoS-based, and coherent-based depending on the protocol operation[7].

Sajid Hussain [07] Use of multiple paths in data gathering for wireless sensor networks balances energy dissipation among nodes in the network and maximizes network lifetime. The lifetime of such sensor system is the time when base station can receive data from all sensors in the network. A single best path puts extra load to a specific node causing lower lifetime. Obtaining paths to balance energy among nodes and use them for suitable number of rounds maximize the network lifetime. Several existing protocols formulate this maximum lifetime data gathering problem as flow augmentation problem and use linear programming approach to solve. Essentially, a path in the network forms a spanning tree rooted at sink. In this paper, we propose an energy efficient spanning tree (EESR) based multi-hop routing in a homogeneous network that maximizes the network lifetime. Given the location of the sensor nodes and base station, EESR generates a sequence of routing paths with appropriate number of rounds that maximize the lifetime of the system. Our simulation results show that our proposed technique outperforms previous methods to maximize network lifetime [8].

Kiran Maraiya [08] Data aggregation is very crucial techniques in wireless sensor network. Because with the help of data aggregation we reduce the energy consumption by eliminating redundancy. when wireless sensor network deployed in remote area or hostile environment. In the wireless sensor network have most challenging task is life time so with help of data aggregation enhance the lifetime of the network [9].

J. N. Al-Karaki [09] A fundamental challenge in the design of Wireless Sensor Networks (WSNs) is to maximize their lifetimes especially when they have a limited and non replenish able energy supply. To extend the network lifetime, power management and energy-efficient communication techniques at all layers become necessary. The data gathering and routing problem with in-network aggregation in WSNs. Our objective is to maximize the network lifetime by utilizing data aggregation and in-network processing techniques. We particularly focus on the joint problem of optimal data routing with data aggregation en route such that the above mentioned objective is achieved. We present Grid-based Routing and Aggregator Selection Scheme (GRASS), a scheme for WSNs that can achieve low energy dissipation and low latency without sacrificing quality. GRASS embodies optimal (exact) as well as heuristic approaches to find the minimum number of aggregation points while routing data to the Base Station (BS) such that the network lifetime is maximized. Our results show that, when compared to other schemes, GRASS improves system lifetime with acceptable levels of latency in data aggregation and without sacrificing data quality[10].

Watfa [10] sensor network data aggregation techniques assume that the nodes are preprogrammed and send data to a central sink for offline querying and analysis. First, the system behavior is preprogrammed and cannot be modified on the fly. Second, the increased energy wastage due to the communication overhead will result in decreasing the overall system lifetime. Thus, energy conservation is of prime consideration in sensor network protocols in order to maximize the networks operational lifetime. An energy efficient approach to query processing by implementing new optimization techniques applied to in-network aggregation. First discuss earlier approaches in sensors data management and highlight their disadvantages. The approach and evaluate it through several simulations to prove its efficiency, competence and effectiveness[11].

Ramesh Rajagopalan [06] Wireless sensor networks consist of sensor nodes with sensing and communication capabilities. It focus on data aggregation problems in energy constrained sensor networks. The main goal of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced. Then compared and contrast different algorithms on the basis of performance measures such as lifetime, latency and data accuracy [12].

Hongjuan Li [11] Data aggregation in wireless sensor networks is employed to reduce the communication overhead and prolong the network lifetime. However, an adversary may compromise some sensor nodes, and use them to forge false values as the aggregation result. Previous secure data aggregation schemes have tackled this problem from different angles. The goal of those algorithms is to ensure that the Base Station (BS) does not accept any forged aggregation results. But none of them have tried to detect the nodes that inject into the network bogus aggregation results. Moreover, most of them usually have a communication overhead that is (at best) logarithmic per node. A secure and energy-efficient data aggregation scheme that can detect the malicious nodes with a constant per node communication overhead. In our solution, all aggregation results are signed with the private keys of the aggregators so that they cannot be altered by others. Nodes on each link additionally use their pair wise shared key for secure communications. Each node receives the aggregation results from its parent and verifies the aggregation result of the parent node. Theoretical analysis on energy consumption and communication overhead accords with our comparison based simulation study over random data aggregation trees[13].

Kiran Maraiya [11] Data aggregation is very crucial techniques in wireless sensor network. Because with the help of data aggregation we reduce the energy consumption by eliminating redundancy. When wireless sensor network deployed in remote areas or hostile environment. In the wireless sensor network have the most challenging task is a life time so with help of data aggregation we can enhance the lifetime of the network . The data aggregation approaches based on the routing protocols, the algorithm in the wireless sensor network and also discuss the advantages and disadvantages or various performance measures of the data aggregation in the network[14].

### **III. METHODOLOGY**

#### **3.1 PRICE-ORIENTED RELIABLE TRANSPORT PROTOCOL**

PORT saves more energy when a smaller uncertainty is required. This is because, when small uncertainty is required, large source reporting rates are needed. As a result, traffic load is high. Packet loss rate along the sensor-to-sink path is then also high. PORT can allocate traffic to alleviate congestion. In this case, PORT saves much more energy than the existing scheme. The reporting rates of the sources overload the network capacity. The network severely congests and thus cannot provide the sink with enough packets. The uncertainty requirement cannot then be fulfilled. As PORT can alleviate congestion by routing via different paths, it allows higher reporting rates than existing schemes and hence it can fulfil a smaller uncertainty requirements It shows that PORT provides a better congestion avoidance scheme.

#### **3.2 SENSOR TO DATA COMMUNICATIONS IN WSN**

Although different WSNs have different task specific requirements, they all require a sensor-to-sink data transport scheme to take account of two important issues. The first is reliability assurance, which means we must guarantee that the sink can obtain enough information about the phenomenon of interest. The second is energy-efficiency, as recharging the sensor nodes is usually impractical. Therefore, a sensor-to-sink data transport scheme should aim to minimize energy consumption under the constraint that the sink can collect enough information on the phenomenon of interest.

The notion of reliability on sensor-to-sink communication was first introduced in, where the authors notice that, unlike existing WSN transport schemes that focus on end-to-end reliable data transferring, absolute end-to-end reliable data transport is usually not needed when transmitting sensor reporting packets. Packet loss within a certain limit can usually be well tolerated in most application scenarios.

First, notice that the packets from different sources may make a different contribution to improve the sink's information on the phenomenon of interest. It regard the contribution of a source node as being how much it reduces the sink's uncertainty on the data about the phenomenon. Thus reliability cannot simply be measured by the total incoming packet rate, as considered in current approaches, e.g., ESRT (Event-to-Sink Reliable Transport). Instead, it should be assured with the cooperation of a reliable sensor-to-sink data transport scheme and network applications.

Second, to achieve reliability, ESRT adjusts the report rates of sources in an undifferentiated manner. But, as the communication cost from different sources to the sink may be different and may change dynamically, and also the contributions of packets from different sources are also different, adjusting the report rates of the sensor nodes in an undifferentiated manner is not the most energy-efficient way to increase the knowledge of the phenomenon. It is therefore necessary to bias the reporting rates of the sources.

Third, to minimize energy consumption, it must avoid links with high communication costs. Congestion always results in an increase in communication cost and congestion control is vital to minimize energy consumption. ESRT proposes to avoid congestion in an end-to-end manner by reducing reporting rates. CODA also proposes to avoid congestion by slowing down sending rates. However, slowing down sending rates may cause the sink to receive fewer packets, which may yield in insufficient information on the phenomenon of interest. In this case, the sink will ask for higher reporting rates and that may cause congestion again if a reliability control mechanism like what ESRT proposes is employed. Therefore, besides an end-to-end congestion-avoidance mechanism, in-network congestion-avoidance mechanism is also necessary. The aim to address these problems by providing a Price-Oriented Reliable Transport protocol (PORT). PORT is based on the following assumptions.

- The sensor reporting traffic lasts for a considerable duration.
- The sink is aware of the sources of data packets.
- The sink is aware of the information a packet carries.

The first assumption means source sensor nodes would keep reporting data on the phenomenon of interest for a long period of time. It is generally valid because in most application scenarios such as environmental monitoring, object tracking, surveillance, *etc.*, WSNs are employed to provide continuous data streaming about the phenomenon of interest.

The second assumption is also reasonable in most application scenarios. This is because of two reasons. First, it is usually necessary for the sink to know the physical location of the phenomenon. Where a packet originates provides information on where the phenomenon of interest is taking place. Second, the sink should usually fuse the data packets it has received. Each source node should be identified in order to provide information on how to fuse the packets. PORT does not require a heavy-weighted address-based approach. It only requires the sink can identify different sources which are reporting data on the same phenomenon. This can be achieved, by randomly generating an identifier and embedding it in reporting packets when a node is sensing and reporting the phenomenon of interest.

The third assumption means that the sink knows how a packet can improve its knowledge on the phenomenon of interest. It is true as the sink is where data packets are interpreted. PORT employs node price, which is defined as the total number of transmission attempts across the network needed to achieve successful packet delivery from a node to the sink, to measure the communication cost from a node to the sink. Under the constraint that the sink must obtain enough in-formation, PORT dynamically feeds back the optimal reporting rate to each source according to the current contribution of the packets from each source and the node price of each source. Based on the neighbouring nodes' feedback of their node prices and the loss rates of the links between the neighbours and the node, an in-network node dynamically allocates its outgoing traffic to avoid high loss rate paths (which are probably caused by congestion). PORT, in this way, alleviates congestion in an in-network manner. Also, congestion will increase the node price of the sources. The source reporting rate control mechanism of PORT is aware of node prices of the sources, and can decide to adjust the source reporting rates (it might slow down one with a high node price and speed up one with a low node price) with a guarantee that the sink can still obtain enough information. Hence, with this in-network congestion-avoidance mechanism and this end-to-end reporting-rate adjustment mechanism, PORT provides a good congestion-avoidance mechanism.

### **3.3 BOU BASIC ALGORITHM**

A direct way to set up the transmitter power level is broad- casting. Broadcasting is performed by setting the power level to the maximal value in order to reach all possible one-hop neighbours. The broadcast packets which carry the information to set up in-network nodes transmitter power level the configuration packets. A configuration packet describes the location, the identity, and the node cost  $\eta$  of the node that sends the configuration packet. The sink first broadcasts a configuration packet. The node cost of the sink is obviously set

to zero. Upon receiving a configuration packet, an in-network node may update the node cost of itself and broadcast another configuration packet with the updated node cost.

Each node that receives a configuration packet computes its own wireless transmitter power setting with which it can reach the node where it receives the configuration packet. The cost of the edge from this node to the neighbour is calculated. The sum of the edge cost and the node cost of this neighbour is the path cost of the path from the node via this neighbour to the sink. If the node has not received any configuration packet before, this path cost is saved as its node cost. This path cost is compared with the current node cost. If the current node cost is smaller, the packet is simply dropped. Otherwise, the node cost is replaced with this path cost and updated node cost is encapsulated in a configuration packet together with node location. The node then broadcasts the configuration packet. Each node know the location of its downstream neighbour through path to the sink is the shortest path. This process builds up a spanning tree rooted at the sink that initially sends out a configuration packet with node cost equal to zero. The path from each node to the sink in the spanning tree is the shortest path in graph given the cost function of each edge.

### 3.4 BOU-WA APPROXIMATION APPROACH

To determine the waiting time before a node broadcasts a configuration packet on the update of its node cost. The scheme that adopts waiting time based on this approximation the BOU-WA (BOU-W with approximation) scheme. Suppose the deployed node number is  $k$  and the deployment area and assume the nodes are deployed uniformly in area. The complexity to calculate the waiting time in this scheme is negligible as a node only the scheme requires no message exchange among sensor nodes. As  $k$  and area known before node deployment they can be programmed into the node.

#### 3.4.1 ALGORITHM FOR BOU

```

STEP 1 : Input Location nodes = n.
           // n is node cost//
STEP 2 : To find n by using neighboring
           //neighboring node to sends sensor-to-sink data packets by using
           //downstream neighbor//
STEP 3 : If wait until receiving a configuration packet
           then
           location information
           else
           Node cost information
           // Information obtained from Configuration Packet//
STEP 4 : Calculated Power level = Neighbor + cost (e)
           // the cost of the edge is node to the neighbor//
STEP 5 : if (cost of the edge < node cost)
           then
           n = neighbor + cost (e)
           else Identified the Broadcast configuration packet
           // the identify of node and location to create configuration packet
           // with node cost//
STEP 6 : until repeat step 1
    
```

### 3.5 COMPARISONS OF BOU AND BOU-WA

The BOU and BOU-WA the network described randomly deploy  $k+1$  nodes in a uniform manner. The randomly select a node as the sink node and the other  $k$  nodes as the in-network sensor nodes. Let the sink node initiate the algorithms. For each setting of  $k$ , run the simulations of the BOU scheme for 1000 times and for each setting of  $k$  and  $\alpha$ , also run the simulations of the BOU-WA scheme for 1000 times. The average results of all the simulation runs in each setting. The total number of broadcasts in setting up the transmitter power levels and the energy consumption overhead of BOU and BOU-WA. It can be found that BOU-WA greatly improves the BOU scheme, especially when the number of nodes is large. Moreover, the greater  $\alpha$  is better the BOU-WA scheme performs. When  $\alpha$  is large different values of  $\alpha$  do not have much different effects on the energy consumption overhead of BOU-WA. The counter-effect of BOU-WA comparing to BOU is that BOU-WA might require larger converging time. The converging times of the BOU and BOU-WA are simulated results show the greater  $\alpha$  is longer the converging time of BOU-WA scheme is. Note that when  $\alpha$  is less than 0.2, BOU-WA has a smaller converging time than BOU. This is because the number of broadcasts in BOU-WA is much smaller than of BOU. The load of the wireless channel is lighter in case that BOU-WA is employed. Therefore, if a node wants to send a packet, it waits for less time until the channel is free in case that BOU-WA is employed.

S.No	Nodes	BOU-W	BOU-WA
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1	100	2.10	2.60
2	200	2.74	4.30
3	300	3.80	5.06
4	400	3.54	2.75
5	500	1.75	1.89
6	100	2.10	2.60

**Table 3.1 Comparison of BOU-W and BOU-WA**

### 3.5.1 ALGORITHM FOR BOU-W & BOU-WA

**STEP 1 :** If there is another configuration packet are scheduled to be broadcasted.

**STEP 2 :** Calculate the probability P and P0 exists.

**STEP 3 :** Check another path to sink of the path cost is smaller.

**STEP 4 :** If  $T = a \times P$

    go to configuration packet broadcasted in T seconds BOU-W

    else

    go to configuration packet broadcasted in T seconds BOU-WA

**STEP 5 :** repeat until step 1.

### 3.6 PROPOSED METHODOLOGY

In typical wireless sensor networks, sensor nodes are usually resource-constrained and battery-limited. In order to save resources and energy, data must be aggregated to avoid overwhelming amounts of traffic in the network. The aim of data aggregation is that eliminates redundant data transmission and enhances the lifetime of energy in wireless sensor network. Data aggregation is the process of one or several sensors then collects the detection result from other sensor. The collected data must be processed by sensor to reduce transmission burden before they are transmitted to the base station or sink. The wireless sensor network has consisted three types of nodes. Simple regular sensor nodes, aggregator node and querier. Regular sensor nodes sense data packet from the environment and send to the aggregator nodes basically these aggregator nodes collect data from multiple sensor nodes of the network, aggregates the data packet using a some aggregation function like sum, average, count, max min and then sends aggregates result to upper aggregator node or the querier node who generate the query. It can be the base station or sometimes an external user who has permission to interact with the network. Data transmission between sensor nodes, aggregators and the querier consumes lot of energy in wireless sensor network. The two models one is data aggregation model and second is non data aggregation model in which sensor nodes are regular nodes that collecting data packet and reporting them back to the upper nodes where sensor nodes are aggregators that perform sensing and aggregating at the same time. In this aggregation model 4 data packet travelled within the network and only one data packet is transmitted to the base station (sink). And other non data aggregation model also 4 data packet travelled within the network and all data packets are sent to the base station(sink), means we can say that with the help of data aggregation process we decrease the number of data packet transmission. And also save energy of the sensor node in the wireless sensor network. With the help of data aggregation we enhance the lifetime of wireless sensor network. Sink have a data packet with energy efficient manner with minimum data latency. So data latency is very important in many applications of wireless sensor network such as environment monitoring, health, monitoring, where the freshness of data is also an important factor. It is critical to develop energy-efficient data-aggregation algorithms so that network lifetime is enhanced. There are several factors which determine the energy efficiency of a sensor network, such as network architecture, the data aggregation mechanism, and the underlying routing protocol. Wireless sensor network has distributed processing of sensor node data. Data aggregation is the technique. It describes the processing method that is applied on the data received by a sensor node as well as data is to be routed in the entire network. In which reduce energy consumption of the sensor nodes and also reduce the number of transmissions or length of the data packet.

### 3.7 DATA AGGREGATION TECHNIQUES

Data aggregation is one of the basic concepts of sensor networks. The idea of data aggregation, or data fusion, is to combine data from different sensors in a way that eliminates redundant transmissions. This is done to prolong sensor network lifetime. The parent calculates the new average using the following formula:

$$Avg_{new} = (Avg \ x \ p) + nv / p$$

Wireless sensor networks consist of sensor nodes with sensing and communication capabilities. We focus on data aggregation problems in energy constrained sensor networks. The main goal of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced. Then compare and

contrast different algorithms on the basis of performance measures such as lifetime, latency and data accuracy.

### **Common Value Agreement (CV)**

After a parent receives values from its children, it first calculates the average of the values; it stores the calculated average and sends it back to its children. Each node stores two values: the cv of its parent and the cv of its children (except leaf nodes). When a node needs to send a new reading to its parent, it subtracts the cv from its reading and forwards the value to its parent. The cv will be updated in case there is a major change in the average of the children. When a parent notices a large change between its children and the cv, the parent resends the new average to its children as the new cv. With our cv approach, sent packets are smaller and therefore leading to less collisions, more energy efficiency and less calculation overhead.

### **3.7.1 AGGREGATE FUNCTIONS EVALUATION**

The calculation approach defers between different aggregate functions. In algorithm, evaluate the 5 basic aggregate functions Sum, Average, Count, Min, Max.

#### **Average Function**

The average function query for the average temperature of the whole network, the query should reach all the nodes where values will be extracted. In our algorithm this is not the case; our algorithm offers the user two approaches to calculate the average. In the first approach, when the query reaches the root node, the root node doesn't forward the query to its children but returns his cv since the cv is the common average between it and its children. In the second approach the query reaches all the nodes but not all the nodes return a value. When a query reaches a node, the node examines its current reading and index. If his current reading still lies within the same index the node doesn't forward any value since his value will not have a noticeable change to the final result. If the current reading doesn't lie in the same index the node changes its index, and sends the cv subtracted from his reading to the parent node. After receiving the new reading the parent notices a large value from his child thus updates his index status and cv if needed according to the previously discussed approaches. Then the parent node calculates the new average. Assume Avg is the old average value, Avg\_new the new average, nv the new value received from the child and p the children count involved in the query. The parent calculates the new average using the following formula: In the second approach, sending the value depending on the index change decreases the overhead of sending packets where the change in reading will not cause a notable change to the overall value; thus, using this approach results in sending a small number of packets. Deciding on what approach to use depends on how accurate the data needs.

#### **Count, Sum, Min and Max Functions**

The Count function is evaluated in a normal approach where the node, if meeting the criteria, sends 1 to his parent where the parent adds the count of his children and forwards them to his parent and so on. The Sum function can also be evaluated using two approaches. The first approach is the usual one where values are sent to the parent node that turn sums them and sends them to his parent and so on. The second approach of evaluating sum is to break the Sum query into two queries, an average query and a count query. In this approach the advantages of average evaluation discussed previously can be used. After a node receives a sum function it sends it's reading as if it is calculating the average and then sends the count. The base station calculates the Sum as Average Count. Deciding on the approach to use depends on the query and the exactness of the result. Our engine on the base station decides what approach to use. The Min and Max function are evaluated in similar approach to the average where the node sends the cv subtracted from his value. The parent node in its turn chooses the largest or smallest (Min or Max) value received, adds to it the children cv then subtracts from its parent cv and sends it to its parent.

#### **Queries with conditions**

For other types of queries that have a condition, our approach should increase the throughput of the query since indexing will help in the injection of the query. Our engine on the base station will parse this query and translate the condition into index. For example, the condition "Where temp>35" will be translated into "Where temp Index > 5" assuming index 5 and its preceding indexes are between 0 and 30. After this translation the query is injected into the network. From the root and on, every parent node checks if it has an index smaller or equal to 5, if yes, it will not forward the query to its children. Thus the query is filtered through the injection state. The root broadcasts the query to its children. Once arrived to each child, they check if they have an index smaller or equal to 5. Thus, for node having the index 5, it ignores the query request, but in the case of the other node, it re-broadcasts the request to all of its children (index > 5) which in their turn, each of them forwards the request if its index is greater than 5. This approach removes the overhead of sending the query to unneeded nodes. This approach increases the energy efficiency of the network.

### **3.7.2 MAXIMUM LIFE TIME DATA AGGREGATION (MLTDA)**

Given a collection of sensors and a base station, together with their locations and the energy of each sensor, find a data gathering schedule, where sensors are permitted to aggregate incoming data packets, with maximum lifetime. Consider a schedule S with lifetime T rounds. Let  $f_{i,j}$  be the total number of packets that node i (a sensor) transmits to node j (a sensor or base station) in S.

Recall that each sensor, for each one of the T rounds, generates one data packet that needs to be collected, possibly aggregated, and eventually transmitted to the base station. The schedule S induces a flow network G

$= (V, E)$ . The flow network  $G$  is a directed graph having as nodes all the sensors and the base station, and having edges  $(i, j)$  with capacity  $f_{i,j}$  whenever  $f_{i,j} > 0$ .

#### **Energy Efficiency**

By the data-aggregation scheme increase the functionality of the wireless sensor network. In which every sensor nodes should have spent the same amount of energy in every data gathering round. A data aggregation scheme is energy efficient if it maximizes the functionality of the network. Network lifetime, data accuracy, and latency are some of the significant performance measures of data-aggregation algorithms. The definitions of these measures are highly dependent on the desired application.

#### **Network lifetime**

The network lifetime is defining the number of data fusion rounds. Till the specified percentage of the total nodes dies and the percentage depend on the application. Some application, simultaneously working of the all the sensor nodes is crucial hence the lifetime of the network is number of round until the first nodes which improves the energy efficiency of nodes and enhance the lifetime of whole network.

#### **Latency**

Latency is evaluate data of time delay experiences by system, means data send by sensor nodes and received by base station(sink). basically delay involved in data transmission, routing and data aggregation.

#### **Data accuracy**

It evaluate of ratio of total number of reading received at the base station (sink) to the total number of generated. There are different types data aggregation protocols like network architecture based data aggregation protocols, network-flow-based data aggregation protocols and quality of service (QOS)-aware data-aggregation protocols designed to guarantee QOS metrics. Here network architecture based protocols are described in detail.

#### **Data Gathering with Aggregation**

Data aggregation performs in-network fusion of data packets, coming from different sensors to the base station, in an attempt to minimize the number and size of data transmissions and thus save sensor energies. Such aggregation can be performed when the data from different sensors are highly correlated. The simplistic assumption that an intermediate sensor can aggregate multiple incoming packets into a single outgoing packet.

### **3.7.3 PROPOSED ALGORITHM FOR MLTDA**

#### **GET AGGREGATE TREE (Flow Network $G$ , Lifetime $T$ , Base Station $t$ )**

```
STEP 1 : initialize  $f \leftarrow 1$ 
STEP 2 : Let  $A = (V, E)$  Where  $V = \{t\}$ ,  $E = \{k\}$ 
        // Let  $G = (V, E)$  is network edge capacities on base station//
STEP 3 : While  $A$  does not span the entire node of  $G$ 
        do
        for each edge  $e = (i, j) \in G$ 
        // Let algorithm with edge reduction //
STEP 4 : If  $\text{maxflow}(V, t) \leq T-1$  for all nodes of  $G$ 
        break
        replace  $G$  with the(A)-reduction of  $G$ 
        return  $G, A$ 
        // To find Maximum flow of reduction of  $G$  //
```

#### **// BUILD AGGREGATE TREE //**

#### **BUILDAGGREGATETREE (Aggregation Tree $A$ , Super Sensor $\emptyset$ , Base Station $t$ )**

```
STEP 5 : find a pair  $(i, j)$  where  $i \in A$  and  $j \in A$ 
STEP 6 : add the edge  $(i, j)$  to  $A$ 
        Update the residual energy of sensors
STEP 7 : for each child node
         $A \leftarrow \text{Build Aggregate Tree}(A, \emptyset, t)$ 
        return  $A$ .
```

Get Aggregate Tree algorithm to get an aggregation tree  $A$  with lifetime  $t$  from an admissible flow network  $G$  with lifetime  $T$ . Throughout this algorithm, we maintain the invariant that  $A$  is a tree rooted at  $t$ . Tree  $A$  is formed as follows. Initially  $A$  contains just the base station. While  $A$  does not span all the sensors, To find and add to  $A$  an edge  $e$  then tree  $A$  together with the edge  $e$  and  $f$  is 1 or the minimum of the capacities of the edges. Finally, compute a collection of aggregation trees from an admissible flow network  $G$  with lifetime  $T$ . Build Aggregate Tree procedure to construct an aggregation tree  $A$  for the sensors from an  $A$ . Observe that  $A$  is a directed tree rooted at  $t$  that is used to aggregate one data packet from each sensor. The residual energy at sensor is to construct (one or more) aggregation trees such that the minimum residual energy among the  $n$  sensors is maximized, thereby maximizing the lifetime of the corresponding data gathering schedule. Initially, aggregation tree  $A$  contains only the base station  $t$ .

#### IV. PERFORMANCE EVALUATION

The Proposed MLTDA model was implemented in the result obtained for the number of nodes and BOU, BOU-WA are tabulated below,

Table	NODES	BOU	BOU-WA	MLTDA	4.1
	100	2.10	2.60	<b>1.79</b>	
	200	2.74	4.30	<b>2.39</b>	
	300	3.80	5.06	<b>2.95</b>	
	400	3.54	2.75	<b>2.60</b>	
	500	1.75	1.89	<b>1.36</b>	

#### Performance Evaluation of MLTDA

The execution network life time comparison of the proposed and the existing approach is shown in figure 4.1. The execution time of BOU-WA is very high when compared to the average execution network life time of the Proposed MLTDA. The average execution time taken by the proposed MLTDA, BOU and BOU-WA for the nodes are 1.79, 2.10 and 2.60 respectively. Thus, the proposed MLTDA has taken very less network life time when compared to the existing BOU and BOU-WA model.

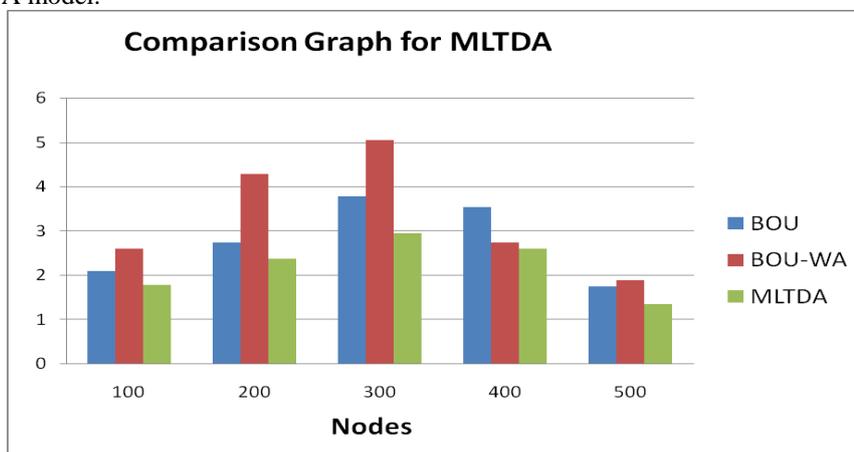


Fig 1.2 Comparison Graph for SSB with Existing Model

#### V. CONCLUSION

Wireless Sensor Network is consisting a large number of sensor nodes. The lifetime of network is limited so the various approaches or protocol has been proposed for increasing the lifetime of the wireless sensor network. In this thesis proposed the data aggregation is one of the important techniques for enhancing the life time of the network and security issues is data integrity with the help of integrity to reduce the compromised sensor source nodes or aggregator nodes from significantly altering the final aggregation value. Sensor node in a sensor network is easily too compromised. The two most important parts of data communication in sensor networks- query processing, data aggregation and realized how communication in sensor networks is different from other wireless networks. Wireless sensor networks are energy constrained network. Since most of the energy consumed for transmitting and receiving data the process of data aggregation becomes an important issue and optimization is needed. Efficient data aggregations not only provide energy conservation but also remove redundancy data and hence provide useful data only. The simulation result shows that when the data from source node is send to sink through neighbours nodes in a multihop fashion by reducing transmission and receiving power, the energy consumption is low as compared to that of sending data directly to sink that is aggregation reduces the data transmission then the without aggregation.

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