ALL ABOUT DATA AGGREGATION IN WIRELESS SENSOR NETWORKS

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Abstract-- A wireless sensor network is a computer network that consists of small devices called sensor nodes. These sensor nodes have the ability to sense different environmental conditions like temperature, pressure, etc. All these sensor nodes send their data to a central node or base station. This creates a large communication overhead the energy source for these nodes is usually a battery. This gives rise to huge consumption of energy and resources. So a solution is required that overcomes the above problems. Data aggregation is one of its solutions. This method consists of aggregators that combine the data coming from the sensor nodes and then passes it to the base station. With the help of data aggregation we reduce the energy consumption by eliminating redundancy and we can enhance the life time of wireless network. The purpose of the proposed paper is to explain data aggregation in wireless sensor network, how it works, different techniques of data aggregation and the comparison among them.

Keyword— Wireless Sensor Network, Energy Consumption, data aggregation.

I. INTRODUCTION

A Wireless Sensor Network (WSN) typically consists of a sink node sometimes referred to as a Base Station and a number of small wireless sensor nodes. The base station is assumed to be secure with unlimited available energy while the sensor nodes are assumed to be unsecured with limited available energy. The sensor nodes monitor a geographical area and collect sensory information. Sensory information is communicated to the Base Station through Wireless hop by hop transmissions. To conserve energy this information is aggregated at intermediate sensor nodes by applying a suitable aggregation function on the received data. Aggregation reduces the amount of network traffic which helps to reduce energy consumption on sensor nodes.[1] It however complicates the already existing security challenges for wireless sensor networks[2] and requires new security techniques tailored specifically for this scenario. Providing security to aggregate data in Wireless Sensor Networks is known as Secure Data Aggregation in WSN.[1][2][3] were the first few works discussing techniques for secure data aggregation in Wireless Sensor Networks.

The wireless sensor network is ad-hoc network. It consist small light weighted wireless nodes called sensor nodes, deployed in physical or environmental condition. And it measured physical parameters such as sound, pressure, temperature, and humidity

The key advantage of using these small devices to monitor the environment is that it does not require infrastructure such as electric mains for power supply and wired lines for Internet connections to collect data, nor need human interaction while deploying. Each device is equipped with a radio transceiver, a small microcontroller, and an energy source, usually a battery. The devices use each other to transport data.

Wireless sensor network have various applications like habitat monitoring, building monitoring, health monitoring, military survival lance and target tracking. These sensor nodes deployed in large or thousand numbers and collaborate to form an ad hoc network capable of reporting to data

collection sink (base station).so they 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. 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 that allows gathering and aggregate data in an energy efficient manner so that network lifetime is enhanced.
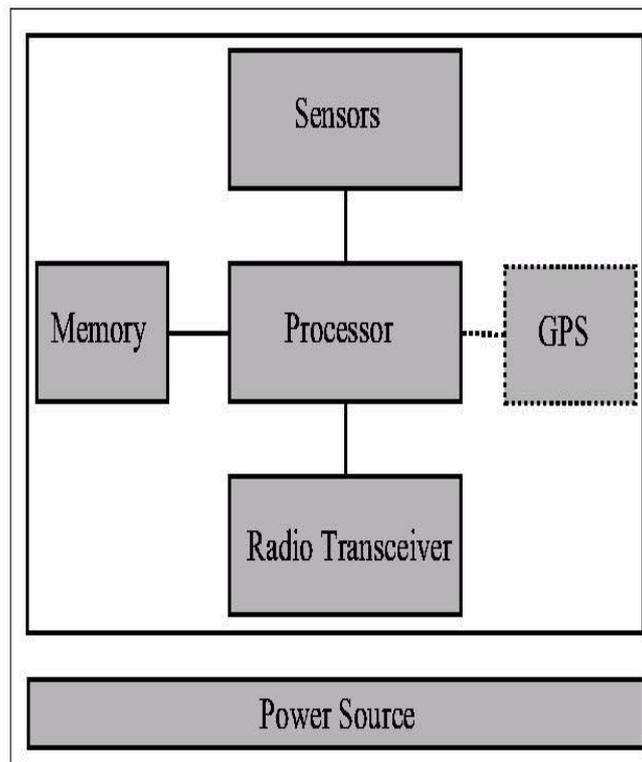

Figure 1 Basic Components of a WSN Node

II. CLUSTERING IN WSN [5]

Sensor node are densely deployed in wireless sensor network that means physical environment would produce very similar data in close by sensor node and transmitting such type of data is more or less redundant. So all these facts encourage using some kind of grouping of sensor nodes such that group of sensor node can be combined or compress data together and transmit only compact data. This grouping process of sensor nodes into a combined large scale sensor node is known as clustering.

The intelligent way to combine and compress the data belonging to a single cluster is known as data aggregation. Following are some issues of clustering in wireless sensor networks:-

1. How many clusters should be formed?
2. How many sensor nodes should be taken in a single Cluster?
3. Selection procedure of cluster head in an individual cluster.
4. User can put some power full nodes, in term of energy in the network which can behave like cluster head and simple node in a cluster work as a cluster member only.

III. PROBLEM DEFINITION

In wireless sensor network, data transmission took place in multi-hop fashion where each node forwards its data to the neighbor node which is nearer to sink. Since closely placed nodes may sense same data, above approach cannot be considered as energy efficient. An improvement over the above approach would be clustering where each node sends data to cluster-head (CH) and then cluster-head perform aggregation on the received raw data and then send it to sink. Performing aggregation function over cluster-head still causes significant energy wastage.[4] Performing aggregation function over cluster-head still causes significant energy wastage. In case of homogeneous sensor network cluster-head will soon die out and again re-clustering has to be done which again cause energy consumption.

IV. AN OVERVIEW ABOUT DATA AGGREGATION

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. There has been extensive work on data aggregation schemes in sensor networks. Data aggregation is a process of aggregating the sensor data using aggregation approaches. Following figure 2 shows basic aggregation in wireless sensor networks.

The wireless sensor network has consisted three types of nodes. 1. Simple regular sensor nodes, 2. Aggregator node, 3. Querier node. 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.
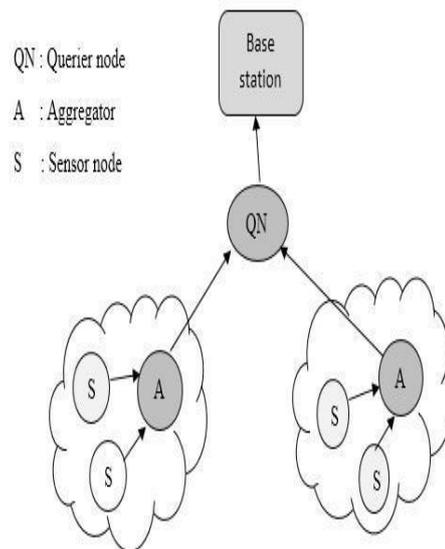

Figure 2 Basic Components of a WSN Node

The data aggregation algorithm collects the sensor data from the sensor node and then aggregates at one particular node. Different type of algorithms are used like centralized approach, LEACH (Low Energy Adaptive Clustering Hierarchy), TAG(Tiny Aggregation) etc. This aggregated data is transfer to the sink node by selecting the efficient path. The general data aggregation algorithm
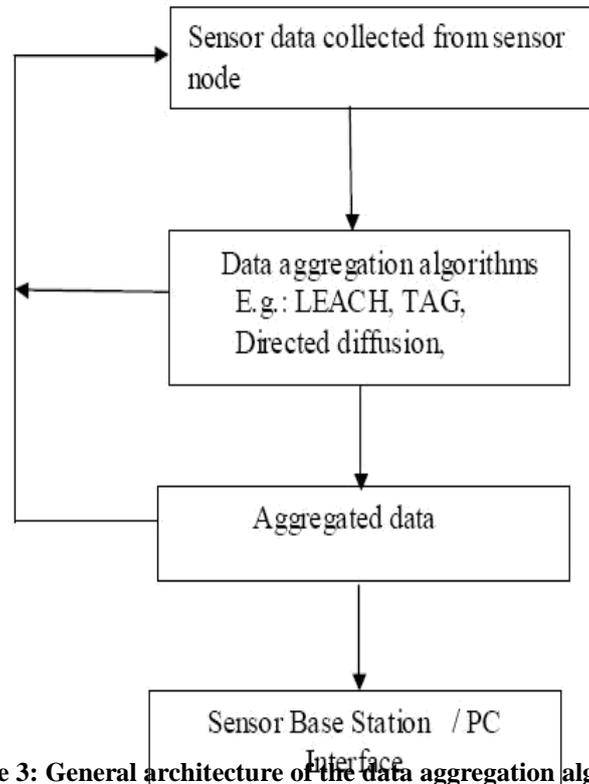
works as shown in the below figure 3.

Figure 3: General architecture of the data aggregation algorithm

V. DATA AGGREGATION APPROACHES IN WIRELESS SENSOR NETWORK

There are many types of aggregation techniques are present some of them are listed below.

5.1 Centralized Approach:
This is an address centric approach where each node sends data to a central node via the shortest possible route using a multi-hop wireless protocol. The sensor nodes simply send the data packets to a leader, which is the powerful node. The leader aggregates the data which can be queried. There is an intermediate node between the sensor node and the leaders. Each intermediate node has to send the data packets addressed to leader from the child nodes.

5.2 In-Network Aggregation [5]:
In-network aggregation, the processes are as following:

1. Gathering and routing information through a multi-hop network,
2. Processing data at intermediate nodes with the objective of reducing resource consumption (in particular energy), thereby increasing network lifetime.

There are two approaches for in-network aggregation [4]:
1. With size reduction and
2. Without size reduction.

With size reduction
It refers to the process of combining & compressing the data packets received by a node from its

neighbors in order to reduce the packet length to be transmitted or forwarded towards the sink.

Without size reduction

It refers to the process merging data packets received from different neighbors in to a single data packet but without processing the value of data.
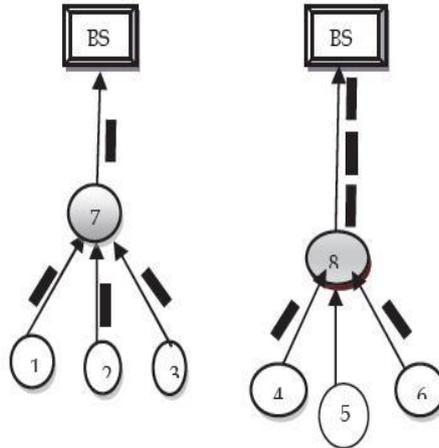

Figure 4. without size reduction and with size reduction

5.3 Tree-Based Approach

The tree based approach is defining aggregation from constructing an aggregation tree. The form of tree is minimum spanning tree, sink node consider as a root and source nodes consider as leaves. Information flowing of data start from leaves node up to root means sink (base station).This approach works in two phases:

1. Distributed phase
2. Collection phase

Disadvantage of this approach is that data packet loss at any level of tree, the data will be lost not only for single level but for whole related sub tree as well.
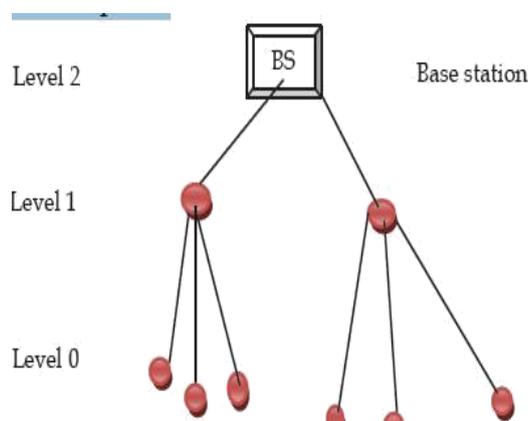

Figure 5. Tree Based Approach

5.4 CLUSTER-BASED APPROACH [4]:

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 cluster heads can communicate with the sink directly via long range transmissions or multi hopping through other cluster heads.

Different data aggregation technique in wireless sensor networks

Algorithm	Type	Advantages	Disadvantages
TAG	Tree Based	Ability to tolerate disconnections and loss	Network life time is limited.
SPIN	Centralized	Simple in nature, implosion, avoidance and economic start up cost.	No feedback mechanism for delivery of the data
DD	Centralized	It extends the network lifetime.	It cannot be used for continuous data delivery.
LEACH	Cluster Based	Low energy, increased lifetime of network	It is not used for large network region.
HEED	Cluster Based	Improved energy efficiency	No Support for heterogeneous node. Lifetime of sensor node is limited.
DRINA	In Network	Data security, Low energy.	Cluster Head dynamically not changes.
M- DRINA	In Network	Achieves more energy efficiency than DRINA and increase the lifetime of network with dynamic selection of cluster head.	No Support, Not applicable for large network region.

VI. PROS AND CONS OF DATA AGGREGATION IN WIRELESS SENSOR NETWORK

- With the help of data aggregation process we can enhance the robustness and accuracy of information which is obtained by entire network, certain redundancy exists in the data collected from sensor nodes thus data fusion processing is needed to reduce the redundant information.
- The number of transmission is reduced so the traffic is reduced
- Load and conserve energy of the sensors.
- The cluster head means data aggregator nodes send fuse these data to the base station .this cluster head or aggregator node may be attacked by malicious attacker. If a cluster head is compromised, then the base station (sink) cannot be ensure the correctness of the aggregate data that has been send to it.
- Another drawback is existing systems are several copies of the aggregate result may be sent to the base station (sink) by uncompromised nodes .It increase the power consumed at these nodes.

VII. CONCLUSION

In this paper we have studied about wireless sensor network. It contains large number of sensor nodes Wireless sensor networks are energy constrained network. That's why lifetime of the network is limited so the various approaches or protocol has been proposed for increasing the lifetime of the wireless sensor network. Since most of the energy consumed for transmitting and receiving data, the process of data aggregation becomes an important issue. Efficient data aggregations not only provide

energy conservation but also remove redundancy data and hence provide useful data only. We also discuss the advantage and disadvantages of the data aggregation.

REFERENCES

[1] Cam, H; Ozdemir, S Nair, P Muthuavinashiappan, D (October 2003). "ESPDA: Energy-efficient and Secure Pattern-based Data Aggregation for wireless sensor networks". Sensors 2: 732–736.

[2] Hu, Lingxuan; David Evans (January 2003). "Secure aggregation for wireless networks" Workshop on Security and Assurance in Ad hoc Networks.

[3] Przydatek, Bartosz; Dawn Song; Adrian Perrig (2003). "SIA: secure information aggregation in sensor networks". SenSys: 255–265.

[4] Kiran Maraiya, Kamal Kant, Nitin Gupta ,"Wireless Sensor Network: A Review on Data Aggregation",International Journal of Scientific & Engineering Research Volume 2, Issue 4, April -2011 ISSN 2229-5518 IJSER © 2011

[5] Nandini. S. Patil, Prof. P. R. Patil," Data Aggregation in Wireless Sensor Network", 2010 IEEE International Conference on Computational Intelligence and Computing Research.