7th National Conference on
"Role of Engineers in Nation Building" organized by VIVA Institute of Technology, Mumbai
(1st and 2nd March 2019)
International Journal of Engineering Research & Science (IJOER)
ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

A Review on Data Aggregation Techniques In WSN

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Abstract— *Sensor network is collection of sensor nodes which co-operatively send sensed data to base station. As sensor nodes are battery driven, and therefore efficient utilization of power is essential so that networks can be used 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. The main aim of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is improved. For this in network processing inside network can be done to 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.*

This paper explains the purpose of data aggregation and gathering in WSN, data aggregation in flat networks and data aggregation in hierarchical networks, different data aggregation techniques in cluster based networks, chain based, tree based and grid based networks.

Keywords— Wireless Sensor networks, data aggregation, dynamic access via wireless connectivity.

I. INTRODUCTION

A wireless Sensor Network is a static ad hoc network consisting of many sensor nodes. Each sensor node is equipped with a sensing device, a low computational capacity processor, a short-range wireless transmitter-receiver and a limited battery-supplied energy. Sensor nodes monitors surrounding data and process the data obtained and forward this data towards a base station located on the sensor network. Sink node in WSN collect the data from the sensor nodes, aggregates the data and transmit this data to remote control station. As sensor nodes are battery operated device, it requires more energy for its working and it need to be optimized for efficient performance of WSN. To improve energy efficiency in WSN, different data gathering techniques are available. They are categorized into different approaches like, topology control, data aggregation, routing protocols. The goal of data aggregation is that eliminates redundant data transmission and improves the life time of energy in wireless sensor network

II. DATA AGGREGATION

2.1 Basics of Data Aggregation:

Data aggregation is the process of aggregating the data from multiple sensors to eliminate redundant transmission and provide aggregated information to the base station. Data aggregation usually involves the fusion of data from multiple sensors at intermediate nodes and transmission of the aggregated data to the base station(sink).

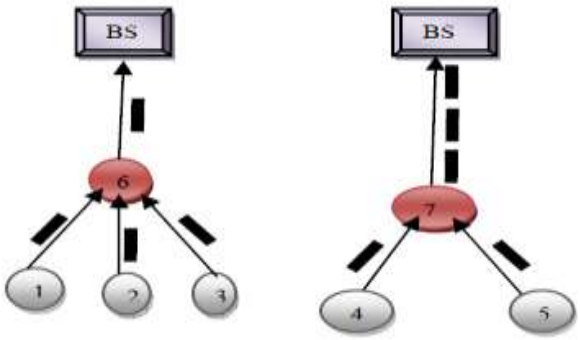

Fig. 1 Data Aggregation Model and Non Data Aggregation Model

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Data aggregation is the process in which one or several sensors then collects the detection result from other sensor and collected data is processed by sensor to reduce transmission burden before they are transmitted to the base station or sink. Figure 1 contain two models one is data aggregation model and second is non data aggregation model in which sensor nodes 1,2,3,4,5 are regular nodes that collecting data packet and reporting them back to the upper nodes where sensor nodes 6,7 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 another non data aggregation model 3 data packet travelled within the network and all data packets are send to the base station(sink).

2.2 Data aggregation approaches in Wireless Sensor networks based on network architecture:

The architecture of the sensor network plays a vital role in the performance of different data-aggregation protocols.

2.2.1 Flat Networks:

Flat networks plays very important role in wireless sensor network, in which each sensor node have an equal battery power and plays the same type of role in a network. In such type of networks, data centric routing technique is used to perform dada aggregation, where the sink generally sends a data packet to the sensor nodes, such as, flooding. In the flooding, sensors which have data matching the data packet and transmit response data packet back to the sink.

2.2.2 Push Diffusion:

Data packet flowing with the help of this diffusion techniques, In which all source node are active participants and start the diffusion while the base station respond to the source node.

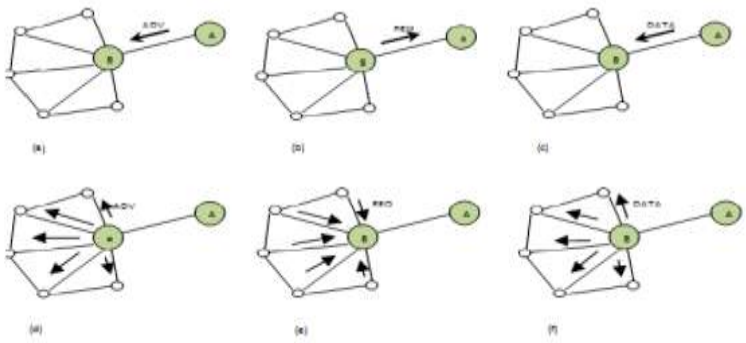

Fig2 (a) Node A starts by advertising its data to node B (b) Node B responds by sending request to Node A (c) after receiving the requesting data , (d) Node B sends out its advertisements to its neighbors , (e-f) who in turn send request back to node B

The sensor protocol for information via negotiation (SPIN) uses push base diffusion protocol. The staring node which has new data advertises the data to the neighboring nodes in the network using the Meta data.

2.2.3 Directed Diffusion:

It is an energy-efficient data-aggregation protocol for a wireless sensor network. In this technique data of the sensor is named by attribute value. By using directed diffusion the life time of the network can be enhanced. In this scheme generally base station broadcast the message to the interested source node. After that each node receives interest. These interests define the attribute

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value such as name of object. Each node the get the interest can cache it for later use. As the interest is broadcasted by the network hop by hop, gradient are setups to draw data satisfying the query toward the requesting node? A gradient is a reply link to the closer from which the interest was received.

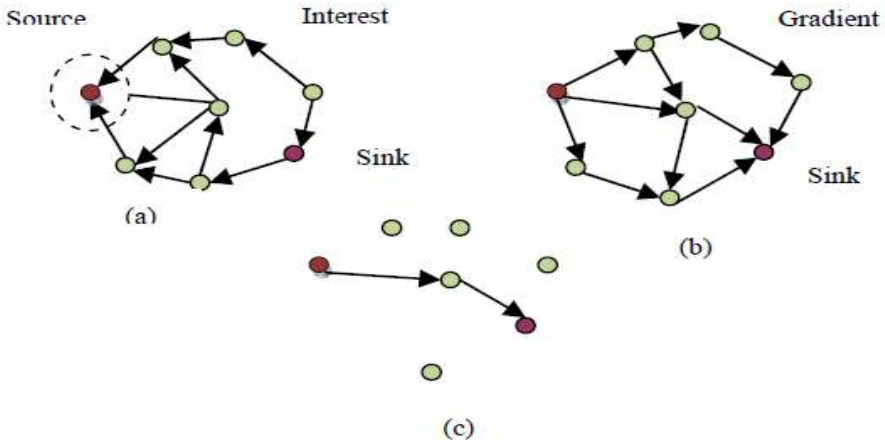

Fig 3 Directed Diffusion Phases (a) Interest propagation (b) Initial gradient set up and (c) Data delivery along reinforcement

2.3 Hierarchical Networks:

In the hierarchical network, data aggregation is done at central nodes, with the help of this node the number of data packet transmitted to the sink is reduced. So this network improves the energy efficiency of the whole network. Various type hierarchical data-aggregation protocols as follows.

2.3.1 Cluster based network for data aggregation:

In Wireless sensor network sensor cannot directly transmit data to the base station. 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 aggregated data to the base station. This scheme save the energy of the sensors. Figure 4 shows a cluster-based sensor network. The cluster heads can communicate with the base station directly.

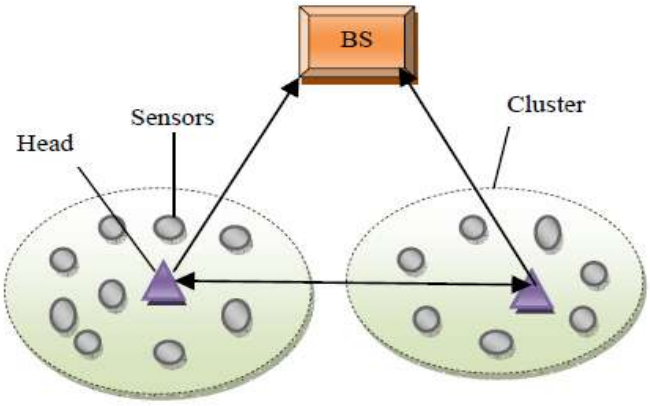

Fig 4 Cluster based Sensor network. Arrow indicates wireless communication links

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LEACH is the cluster-based network and data-aggregation protocol, Low-Energy Adaptive Clustering Hierarchy (LEACH). It is 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 steady-state phase. Involves data aggregation process has to be done at cluster heads and data transmission to the base station (sink).

2.3.2 Data aggregation in chain based network:

In this each sensor sends data to the closer neighbor. Power- Efficient Data-Gathering Protocol for Sensor Information Systems (PEGASIS) is type of chain based data aggregation. In PEGASIS, all sensors are structured into a linear chain for data aggregation. The nodes can form a chain by using a greedy algorithm or the sink can decide the chain in a centralized manner. In the Greedy chain formation assumes that all sensors have knowledge of the network. The farthest node from the sink initiates chain formation and, at each step, the closest neighbor of a node is selected as its successor in the chain. In each data-gathering round, a node receives data packet from one of its neighbors, aggregates the data with its own, and sends the aggregates data packet to its other neighbor along the chain. Eventually, the leader node in they are similar to cluster head sends the aggregated data to the base station. Figure 11shows the chain based data-aggregation procedure in PEGASIS.

Fig 5 Chain in PEGASIS

2.3.3 Tree based data aggregation:

In which all node 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.

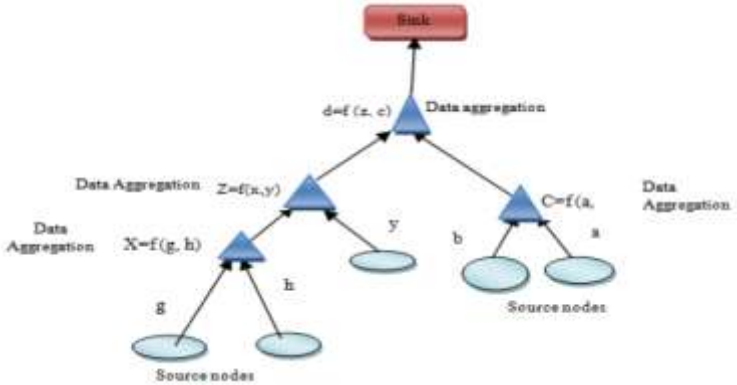

Fig. 6 minimum spanning tree based routing protocol in SN. Arrow indicates the routing path anf f(..,..) is the data aggregation function.

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An energy-aware distributed heuristic (EADAT) and Tiny Aggregation (TAG) are used to construct and preserve a data aggregation tree in sensor networks. TAG works in two phases: distribution phase and collection phase. If we talk about distribution phase, TAG organizes nodes in to a routing tree rooted at sink.

2.3.4 Grid based data aggregation:

There are two data aggregation schemes which are based on dividing the region monitored by a sensor network into several grids. They are: grid based data aggregation and in-network data aggregation.

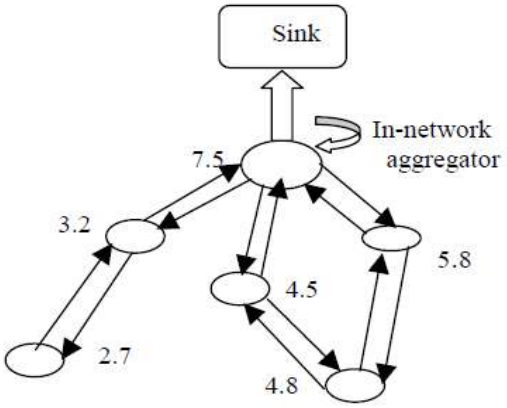

Fig. 7 in network data aggregation scheme The number indicates the signal strengths Detected by sensor. Arrow indicates the Exchange of signal strengths between Neighboring nodes

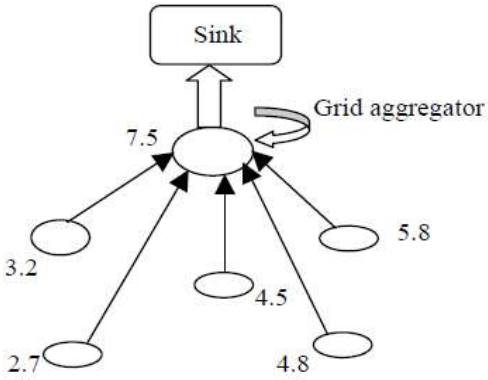

Fig. 8 Grid based data aggregation. The indicates the transmission of data from sensors to grid aggregator

Table 1
Comparison between hierarchical network and flat network

Hierarchical network	Flat network
Data aggregation performed by cluster heads or leader node	Data aggregation is performed by different nodes along the multi-hop path
Overhead involved in cluster or chain formation throughout the network	Data aggregation routes are formed only in regions that have data for transmission
Even if one cluster head fails, the network may still be operation	The failure of sink node may result in the breakdown of entire network
Lower latency in involved since sensor nodes perform short rang transmission to the cluster head	Higher latency is involved in the data transmission to the sink via multichip path.
Routing structure is simple but not necessarily optimal	Optimal routing can guaranteed with additional overhead
Node heterogeneity can exploited by assigning high energy nodes as cluster heads	Does not utilize node heterogeneity for improving Energy efficiency.

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Table 2
Comparison of various data aggregation Techniques

Algorithm	Type	Advantages	Disadvantages
TAG	Tree based	Ability to tolerate disconnections and loss.	Network life time is limited
SPIN	Chain based	Simple in nature, implosion avoidance and economic start up cost	No feedback mechanism for delivery of the data.
DD	Chain based	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.	Not applicable for large network regions

III. CONCLUSION

The phenomenal growth in distributed wireless communication technology has led to the production of a wireless sensors which are capable of observing and reporting various real world phenomena in a time sensitive manner. However such systems suffer from band- width, energy and throughput constraints which limit the amount of information transferred from end-to-end. Data aggregation is a known technique addressed to alleviate these problems. 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. Cluster based and in-network algorithm is mostly used for low energy consumption and increase the life time of network.

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