A SURVEY ON ENHANCING CONVERGECAST IN WIRELESS NETWORKS

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Abstract— Data Collection from the sensors to the sink based on tree topology is the basic operation in wireless sensor networks. Convergecast is defined as a many-to-one communication paradigm. By considering single frequency channel, the time slots are reduced but the interference occurs and by using multiple frequency channel the interference is reduced. For transferring the packet from sensors to sink, the TDMA scheduling is used and a degree constrained spanning tree is finally constructed in order to reduce the overhead on each node by considering its load comparing with other nodes. To improve the data collection the capacity at each node is adjusted whenever the packet moves from one sensor node to another sensor node.

Index Terms— Convergecast, Data Collection, TDMA Scheduling

I. INTRODUCTION

Wireless sensor networks can be used in various applications areas such as health, military, home. A sensor networks consists of large number of nodes that are inside the network or very close to it. The location of each sensor node is not predetermined and each sensor nodes contains its own self organizing capabilities. The unique feature of sensor nodes is the cooperative effort of sensor nodes. Instead of sending the raw data to the nodes responsible for the synthesis, sensor nodes use their processing abilities to locally carry out simple computations and it will transmit only the required and partially processed data. Sensor nodes are used for continuous sensing, detecting events, event ID, sensing the location. A sensor network design includes many features such as fault tolerance, scalability, production costs, operating environment, sensor network topology, hardware constraints, transmission media and power consumption.

Data collection is the basic operation in wireless sensor networks. The sensor nodes measure attributes about the phenomenon of interest and it transmits the data to a common base station. The collected data is forwarded to a common sink through sensors over a tree based routing topology. This is a many to one communication paradigm in which data flows from many nodes to a single node and it is called as convergecast. Once the data is collected at the sink, it can be either recorded or stored for future analysis, or it can be processed immediately to take certain actions depending on application requirements. [5]

In a wireless sensor networks the data collection can be insisted by external sources, such as queries in order to get the outline of network or it can be for continuous monitoring without any external sources.

In TDMA, nodes communicate on different time slots in order to prevent conflicts. By communicating on different time slots, the TDMA based communication provide guarantee delivery. In TDMA schedule, time slotted and each slot is long enough to transmit and receive of a single packet. Hence the time slots are grouped as a non-overlapping frames and the schedule for each frame is repeated when the data collection is periodic. The main objective of TDMA design is to minimize schedule length, minimize Latency, minimizing energy consumption, maximizing capacity, maximizing fairness, minimizing communication costs, maximizing the parallel transmission, meeting deadlines, and minimizing interference.

II. RELATED WORK

Capacity of data Collection in WSN

Collecting data is the basic operation in wireless sensor networks. Collecting those data in a well-organized manner is more critical when compared to the performance of sensor networks. Each sensor will measure the values at regular time intervals and it will send that to sink node. The total collection of data is called as snapshot.

Siyuan Chen et al.,[4] discussed about the hypothetical limits of data collection capacity. Here the sensor network is a TDMA based network. In the past, the data collection capacity is based on large scale random networks, though most of the sensors are not deployed uniformly and the available sensors will not be as huge as in theory. For this purpose we have to know about the capacity of data collection in a network. The capacity of data collection shows how the sink collects data from sensor nodes quickly by considering its interference conditions. The upper and lower bounds for data collection capacity are constructed based on the protocol interference and disk graph models. A simple BFS tree based method is used to achieve the collection capacity which matches the upper bound [4].

Realistic and efficient Multi channel Communication

Yafeng Wu et al.,[7] discuss about the improvement of communication performance by using multiple channels. The current multi channel protocols are not suitable for wireless sensor networks due to minimum number of available channels and unavoidable time errors found in networks. Here a novel tree based multi channel scheme for
Distributed time- optimal scheduling

In sensor networks the packets generated by each and every node have to reach the sink. This many – to –one communication is known as convergecast. A TDMA schedule is used which minimizes the total time required to complete the convergecast.

A simple version of problem is considered where every node generates exactly one packet. Yin Zhang et al.,[8] constructed a distributed scheduling algorithm for the tree networks that requires at most $\max(3n_1 – 1, N)$ time slots for convergecast, where $n_1$ represents the maximum number of nodes in any sub tree and N represents the number of nodes in network. The Distributed scheduling algorithm requires at most 3N time slots in any network. The proposed simulation shows that the number of time slots required is about 1.5 N. Two bounds are required for the packets to be buffered at the node during convergecast. Sleep schedules for nodes are considered for conserve energy. It reduces the energy consumption by at least 50%. Breadth first search tree is considered for convergecast scheduling.

Spanning tree based algorithms for low latency and energy efficient data aggregation

S.Upadhyayula et al.,[6] address the problem of performing the operation of Data Aggregation enhanced Convergecast(DAC) in an energy and latency efficient manner. By assuming as all the nodes in the network have a data item and there is an a priori known application dependent data compression factor, the total data is collected.

Two DAC tree Algorithms are constructed. First is the use of minimum spanning tree and the second is the use of single source shortest path spanning tree algorithm. These two algorithms are combined in order to construct an energy optimal DAC tree for any fixed value. The nodes in this tree are scheduled as a collision free communication using a channel allocation algorithm. In order to achieve low latency the s constraint which puts soft limit on the minimum number of children a node have in a DAC tree.

Scheduling algorithms for tree based Data collection

Collecting data from sensor nodes is the primary operation in Wireless sensor networks, where sensor nodes determine attributes about the observable fact of interest and transmit their readings to the sink. This is a many-to-one communication, in which data flows from many nodes to a common sink and it is called as convergecast. Once the data is collected it can be either recorded and stored for further analysis or it can be processed immediately to take certain actions depending on the applications requirements.[5]

In WSN the data collection occurs when any external event triggers, such as queries or events or it can be for continuous periodic monitoring without any external triggering occurs. When the number of source node are large or if the data rate is high then carrier sense multiple access protocols, such as CSMA may fail to allocate the medium which cause retransmissions and collisions. For this purpose TDMA is developed.

Ozlem Durmaz Incell et al.,[5] describes the contention free Time Division Multiple access scheduling based protocols for collecting data using tree based routing topologies. By using TDMA the nodes can communicate on different slots to prevent interference and conflicts. Consecutive time slots are grouped into non overlapping frames. Hence the schedule for each frame is repeated when data collection is periodic. TDMA also provides guaranteed completion time for data collection. The algorithms are classified according to the design objectives. In order to minimize schedule length, minimize latency, minimize energy consumption, and to maximize fairness the algorithms are analyzed.

By using multi-hop TDMA spatial reuse of time slots are allowed and more than one node can transmit simultaneously if the receivers are in non – conflicting parts of the network. In order to minimize the schedule length the raw data convergecast and aggregated convergecast are used.

A Tree based Data collecting Network structure

Wireless sensor network consists of hundreds to thousands of wireless sensor nodes and those nodes are randomly distributed. Low cost sensors contains low signal-to-noise ratio, so it allows higher level of redundancy. Thus the redundancy makes the network more robust to changing environment. The wireless sensor nodes are battery – powered equipment so battery replacement or recharges are impractical.

In WSN the energy saving scheme is based on clustering. A network is divided into number of clusters and a cluster head is selected from those clusters. It will collect data from cluster members. By using clustering significant improvement in network lifetime is obtained but it also introduces bottleneck problem.

To avoid the bottleneck problem the Chi-Tsun Cheng[1] modifies the network topology from star based to tree based. The network structure is formed based on two approaches namely top down approach and bottom up approach and the network formation may be either centralized or decentralized. By comparing with minimum spanning tree and a single hop network the author shows that this network structure is efficient in terms of collecting data at the time.

Cluster – tree based Data gathering

Wireless sensor network consists of large number of small sensors with low power transceivers will be an effective tool for gathering data in variety of environment [2]. The sensors will sense the data and it will help to monitor and aggregate the data. The important requirements for gathering data includes network lifetime, scalability and load balancing. In order to utilize the energy efficiently different methods are used such as cluster-based, tree-based and chain-based.

Gurpreet Singh Chhabra and Dipesh Sharma[2] uses both cluster based and tree based protocols to improve the power consumption by improving First node death(FND) and it avoids the communication directly between sink and sensor.
nodes. The proposed method reduces the power consumption on avoiding communication directly between sink and sensor nodes. It also increases the network lifetime as compared with others. This cluster based protocols works on two phases. In first phase the network lifetime is minimized by balancing the energy consumption nodes and in second phase the communication overhead in reduced by forming the tree structure.

An efficient data collection approach for WSN

Wireless sensor networks consists of sensor nodes which are connected to each other. The sensor nodes will collect data and it will forward it to the common base station. The sink broadcasts the request and one node tries to transmit data with the help of other nodes. This WSN is based on three categories: Cluster based, Chain based and Tree based. When one node fails then consequently the chain of data transmission will be lost in chain based structure. In Cluster based structure, the cluster head or aggregator node may be attacked by malicious attacker. Thus if the data collection in not performed efficiently, traffic and energy consumption occurs.

Hanieh Alipour and Alireza Nemane Pour[3] proposes an efficient approach for data collection in wireless sensor network by using Member Forward list. Here a tree based algorithm is used for forwarding the data and this MFL helps other nodes to find the route for forwarding data when previous forwarder node has failed. By using this MFL shortest path is identified for forwarding data to the sink. This protocol decreases the latency, increases the energy efficiency and prevents the algorithm from repeating when a node has failed or died for some reasons.

III. CONCLUSION

Wireless sensor networks can be used in various applications areas. A sensor networks consists of large number of nodes and the location of each sensor nodes is predetermined. In this paper different data collections methods are studied. By using TDMA, the nodes communicate on different time slots in order to prevent conflicts. In order to improve the data collection the capacity at each node is adjusted whenever the packet moves from one sensor node to another sensor node.

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