Enchancing the Data Collection in Tree based Wireless Sensor Networks

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Abstract— Number of techniques used in Wireless Sensor Network to improve data collection from sensor nodes. It achieve by minimize the schedule length and dynamic channel assignment. Schedule length minimized by BFS algorithm without interfering links. Interfering links can be eliminated by transmission power control and multi frequency. The power can be save by using beacon signal. Collection of data can also be limited by topology of network. So the nodes are arranged in form. The capacitated minimal spanning trees and degree- constrained spanning trees give significant improvement in scheduling. Finally the data collection is enhancing in terms of security by using T-Hash Chain algorithm.

Key terms: Convergecast, beacon signal, Scheduling, aggregation, Multi channels, routing trees.

I. INTRODUCTION

The sensor nodes sense the outside environment and transfer the sensed data to controller through number of sensor nodes. This is a basic operation in wireless sensor networks (WSN) [1]. We use the wireless sensor network from home application to industry applications. Because it plays a very important role in our life. For example in home application we use sensor in air cooler remote to sense room temperature. In industry application for example in oil industry the sensor nodes detect oil or gas leakage. Here we study two types of data collection. (i) Raw data convergecast (ii) aggregated convergecast. Many-to-one is known as convergecast.

The data packets are individually relayed to the sink through a network in raw data convergecast. It is for one-shot data collection. In aggregated convergecast the summarized data is collected. For example in outside temperature calculation the sensor node aggregate different temperature by using average or maximum or minimum value. Data compression is occurred in aggregated convergecast not in raw data convergecast. TDMA (Time Division Multiple Access) are better choice to enhance data collection because it eliminates interference and retransmission. TDMA also helps to minimize schedule length.

Quick access of data is limited by (i) interference in wireless network (ii) half duplex (iii) topology of network (iv) security. We implement number techniques and algorithms that provide success improvements. For enhancement we join transmission power control with scheduling, multiple frequency allow concurrent transmission of data. Topology of network form in tree based. It helps us for further enhancement.

A. *Interference*

Interference is a one of the factor of limiting the data collection fast. So it can be eliminated by transmission control and multi frequency. Once we eliminate the interference and we can achieve lower bound scheduling. Lower achieve by BFS-Timeslot algorithm without any interference.

B. *Topology*

The sensor nodes must be placed within range with each other. That is sensor nodes coverage area must be interlink. Aggregation performance 10 times improved by using degree- constrained spanning trees. For raw data combination of multi-channel scheduling and capacitated minimal spanning trees minimizes the schedule length by 50%.

In Fig 1 the sensor nodes placed in tree topology based. Black color node is a sink. Other nodes are child nodes of sink. The child nodes send the data to parent node and it send to sink. Parent node aggregate data which is collected from its children node. Parent node does not send data to sink before it collects data from its entire children node. This problem is found by Chen et al. [8].

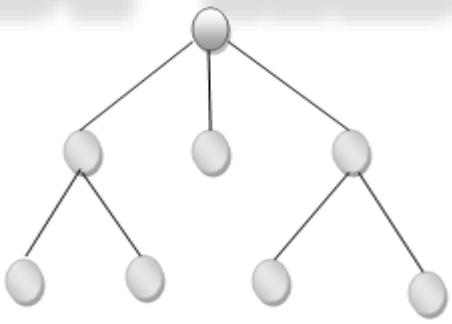

Fig 1. Topology of sensor network.

C. *Channel Assignment*

We evaluate three channel assignment performance (i) Joint Frequency and Time Slot Scheduling (JFTSS), (ii) Receiver-Based Assignment(RBCA) [4] and (iii) Tree-Based Channel Assignment (TMCP) [5].This method concentrate channel assignment problem at different methods link level, node level or cluster level. We analysis that TMCP perform better in aggregated convergecast compared to JFTSS and RBCA on minimum-hop routing trees. But TMCP performs worse on degree constrained trees. RBCA and JFTSS perform better than TMCP for raw-data convergecast.

II. RELATED WORKS

The goal of enhance data collection is minimize the schedule length for aggregated has been studied by us in [4] [6] [3] [7] [8].Raw data also studied in [2] [9]-[11].Evolution of different channel assignments methods and tree topology has been studied in [1].To enhance data collection we use above mentioned channel techniques and algorithms.

In previous work we studied data collection is limited by interference, topology, schedule length. We did not consider and study out security [1]. What is the usage of enhancement with attackers? Attacker may change our data or they deviate data from correct path. So security also very important factor to enhance the data collection. In our work we provide security by using T-Hash chain algorithm.

III. TDMA SCHEDULING

First we focus on periodic aggregation convergecast. It is to calculate the minimum achievable schedule length using an interference aware TDMA protocol.

A. *Periodic Aggregation*

Data aggregation is a common technique in wireless sensor network it removes redundancy and reduces the transmission power control. This aggregation leads to reduce power consumption for data transmission and improve the life of sensor node. Aggregation performed in many ways

1) Data compression
2) Data correlation.

By using encryption and decryption concept the sensed data can be aggregated. Data correlation is performed by readings.

For example in continuous monitoring application all the nodes have capability to aggregate the data which is received from its children node and finally itself it generate single packet before send to other node.

In temperature aggregation process the node collect all values from its children node and finally it take AVG or MIN or MAX value of temperature is send to other nodes.

1) *BFS-Timeslot Assignment Algorithm*

Lower bound is achieved by using BFS algorithm without interfering link. Present timeslot is combine with BFS algorithm is called BFS-Timeslot Assignment [1].

BFS algorithm search from root node to child node. This also used for connectivity maintenance. In edge each of graphs the minimum different timeslot is assigned.

BFS-Time Slot Assignment Algorithm

1. Input $T = (V, E_T)$
2. while $E_T \neq \emptyset$ do
3. e← next edge from E_T in BFS order
4. Assign minimum time slot t to edge e respecting adjacency and Interfering constraints
5. $E_T \leftarrow E_T \setminus \{e\}$
6. end while

2) *Local-Timeslot Assignment*

We combine the timeslot with local algorithm is called Local-Timeslot Assignment; it runs locally by each every node at every time slot. Sensed data is transfer sink from top sub-tree.

Sink cannot receive all data from more nodes at a time. So sink collect data from top sub-tree which one has large number packets. Sink buffer must be kept busy when sink receives data.

If top sub tree buffer is empty then sink collect data from child of top sub tree likewise sink receive data from top to bottom.

Local-Time Slot Assignment Algorithm

1. Node. Buffer = full
2. if{node is sink} then
3. Among the eligible top-subtree, choose the one with the largest number of total(remaining) packets, say top-subtree i
4. Schedule int(root(i),s)respecting interfering constraint
5. Else
6. If{node.buffer==empty} then
7. Choose a random child c of ode whose buffer is full
8. Schedule link(c,node) respecting interfering constraint
9. C.buffer = empty
10. Node.buffer = full
11. end if
12. end if

IV. MULTICHANNEL SCHEDULING

Multi-channel is a method to eliminate interference by enabling concurrent transmission over different frequency. We explain three channel assignment methods and it consider the channel assignment problem at different level: link level (JFTSS) node l level (RBCA), or cluster level (TMCP).

A. *Joint Frequency Time Slot Scheduling (JFTSS)*

JFTSS provide greedy joint solution for constructing maximum schedule. A schedule is said to be maximal if it meets adjacency and interfering constraints. JFTSS for single-channel systems and multi – channel systems are discussed in [12] and [13] respectively.

JFTSS schedules a network. The schedule is starting from the link which has the highest number of packets to be transmitted. Suppose if the link loads are equal such as in aggregation, the most constrained link is to be schedule first. JFTSS first it sort the link according to the loads and constraints. If the time slot is filled by loads then the next time slot is assign for arriving loads. Likewise JFTSS schedule network.

Advantage of JFTSS is easy to incorporate the physical interference model, but it is hard to have a distributed solution.

B. *Tree-Based Multi-Channel Protocol (TMCP)*

TMCP is a greedy, tree –based, multi-channel protocol for data collection application [5]. TMCP partition the network into subtree then it minimize the intratree interference by assigning different channels to nodes that residing on different branches starting from top to bottom. The time slots are assigned to nodes by using BFS Time Slot Assignment algorithm [1].

Advantage of TMCP is it is designed to support convergecast traffic and does not require channel switching. Contention inside the branch not resolved since all nodes on same branch communicate on the same channel.

C. *Receiver-Based Channel Assignment (RBCA)*

In RBCA we statically assigned the channels to the receivers to remove many possible interfering links. The children of a common parent transmit on the same channel. The algorithm assigns the same channel to the entire receiver. After that it create set of interfering parents based on SINR threshold [1] and iteratively assigns the next available channel starting from most interfered parent.

To avoid overlaps over adjacent channel SINR value at receiver may not always high.

Since all interfering parents are assigned different frequencies sink can receive on static frequency.

D. *Routing Trees*

The network topology and degree of connectivity also affect the scheduling performance. In this section we describe algorithm to construct topologies with specific properties to minimize schedule length.

E. *Aggregated Data Collection*

Aggregation means the sink node collect information from their children node and finally the collected data are compressed as a single packet and it sends to nearby nodes. First we construct trees then we compare their performance with unbalanced trees. In both case bottleneck problems occurred often.

To overcome this we use heuristic it is described in Degree-Constrained Trees [1]. The algorithm starts with the sink node, and adds a node at every iteration to the tree. When it reaches maximum degree it stops to add nodes with in tree. If we limit the number of children per node and by enough frequencies then we will reduce schedule length. The Degree –Constrained Tree algorithm had detailed and each steps gives brief explanation.

Degree-Constrained Trees Algorithm

```
1.  Input: G(V,E),s,max_degree
2.  T ← {s}
3.  For all i ϵ V do
4.  C(i) ← 0; HC(i) ←∞
5.  end for
6.  HC(s)←0
7.  While |T| ≠ |V| do
8.  Choose i` Є T such that:
      a. (i,i`)ϵ E, for some i ϵ T with C(i) < max_degree-1
      b. HC(i`) is minimized
    T ← T U {i`}
9.  HC(i`) = HC(i)+1
10. C(i)← C(i)+1
11. If iϵ V, C(i)=max_degree then
12. Break
13. end if
14. end while
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F. *T-Hash Chain Algorithm*

The sensor nodes are arranged in tree based by using above algorithms. The sink nodes are placed between the nodes. Some of the nodes only sense data and remaining nodes transfer the gathered information.

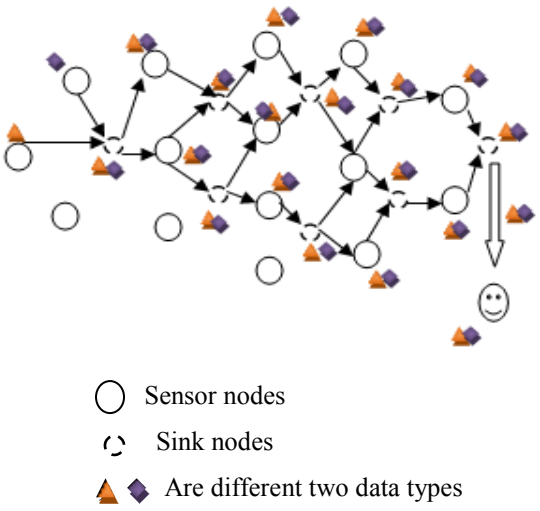

Fig. 2. Aggregation Process

In fig 2 the sensor nodes sense the information and it forward to the nearby sink nodes. The sink node had collected the data from many sensor nodes and finally sink aggregate the data and forward that aggregated or compressed packet to the its nearby children nodes. Likewise up to controller this process will be continued. If any sensor had lost or didn't receive the data packet, that sensor can collect the packet from the neighbour sink node.

Aggregation process avoids

(i) Duplication copy of data,
(ii) Reduce schedule length
(iii) Reduce the loss of data.
(iv) Reduce congestion

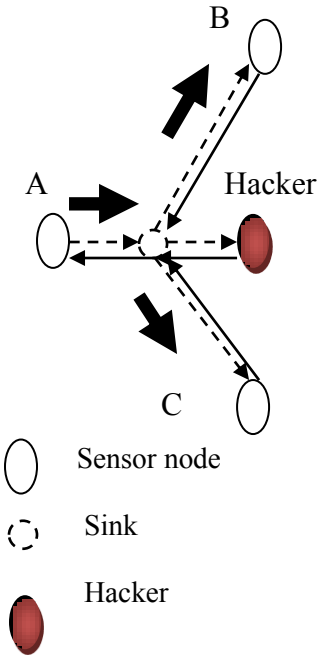

Fig 3. Data sent Using T-Hash chain

In Fig 3 node A send security question to the nearby children nodes. If node the nodes send the correct answer then node A sends the sensed data to that near nodes. Else it will not send the data to the node which one sent the wrong answer. Each and every time the security questions changed.

In here red color node is a hacker node. So node A did not send a packet to hacker node. Likewise each and every data transaction the security questions throw between nodes and sink. By this algorithm we can enhance the data collection from tree based wireless sensor networks.

G. *Efficient Usage of Power*

The node will go to ideal mode when it does not send the packets. If the near node wants to send the packet to ideal node means the near node send beacon signal to that ideal node. After that the ideal node comes and it gets ready to receive the data. In that time the node act as a busy node, when it is transmitting. After the transaction completion the again goes to ideal mode. By this way we can consume the power.

V. CONCLUSION

In this paper we studied enhanced convergecast in WSN. The sensor nodes are arranged in tree topology by using three algorithms. In here node communicate using TDMA to reduce the schedule length. A power is saved by sending bacon signal. We observed that RBCA and JFTSS channel assignment schemes are more efficient method compared to TMCP to eliminate interference. By using T-Hash chain the hackers identified and will not send the data to that node.

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