Tree-Based Wireless Sensor Networks: Fast Data Collection

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***Abstract*: We worked on the speed of information that could be collected from a tree based wireless sensor network. In order to explore this, we evaluated and explored different techniques using realistic simulation models under the paradigm known as converge cast for many-to-one communication. Time scheduling is first considered on a single frequency channel with the aim of minimizing the number of time slots required to complete a converge cast.**

Scheduling is combined with transmission power control to ensure to reduce the effects of interference and for a single frequency power control helps in reducing the length of schedule. Multiple frequencies for scheduling transmissions are more efficient. Schedule length is lower bounded when interference is completely eliminated. The performance of various channel assignment methods is then evaluated and we find empirically that for moderate size networks, most of the interference is removed because of the use of multi-frequency scheduling.

The data collection rate no longer remains limited by the topology of the routing tree and not by the interference. We capacitated minimal spanning trees and constructed degree-constrained spanning trees and found that scheduling performance for different deployment densities is improved significantly. The change in the schedule length is evaluated for different interference and channel models.

***Keywords*: Tree, MANET, MAC, WSN**

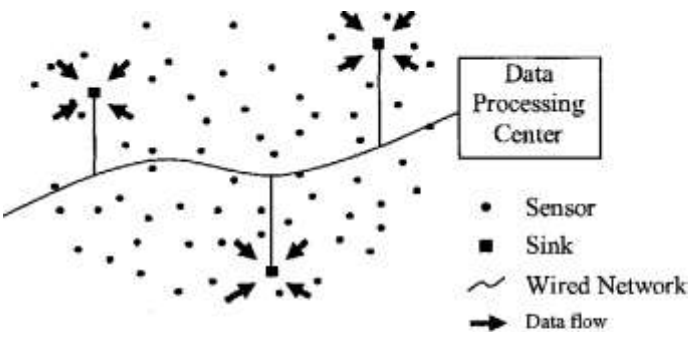
ALGORITHM USED:

1. BFSTIMESLOTASSIGNMENT.
2.LOCAL-TIME SLOT ASSIGNMENT

Algorithm 1 BFS-TIMESLOTASSIGNMENT
1. Input: T = (V, ET)
2. While ET _= φ do
3. e ← next edge from ET in BFS order
4. Assign minimum time slot t to edge e respecting adjacency and interfering constraints
5. ET ← ET \ {e}
6. end while

Algorithm 2 LOCAL-TIME SLOT ASSIGNMENT
1. node.buffer = full
2. if {node is sink} then
3. Among the eligible top-subtrees, choose the one with the largest
number of total (remaining) packets, say top-subtree i
4. Schedule link (root(i), s) respecting interfering constraint
5. else
6. if {node.buffer == empty} then
7. Choose a random child c of node 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

ARCHITECTURE:



EXISTING SYSTEM:

Existing work had the objective of minimize converge cast's completion time. None of the previous work discussed the effect of multi-channel scheduling together with the comparisons of different channel assignment techniques and the impact of routing trees and none considered the raw converge cast and the aggregated problems.

PROPOSED SYSTEM:

We have studied the fast data collection with the goal to minimize the schedule length for aggregated converge cast. The impact of transmission power control was investigated through experiments. Schedule length for multiple frequency channels were tested. We evaluate transmission power control under realistic settings and compute lower bounds on the schedule length for tree networks with algorithms to achieve these bounds and this is where we are different. Different channels have different efficiency assignment methods is compared and propose schemes for constructing specific routing tree topologies that enhance the data collection rate for aggregated and raw-data converge cast system.

MODULES:

1. **Periodic Aggregated Converge cast.**
2. **Transmission Power Control**
3. **Aggregated Data Collection**
4. **Raw Data Collection**
5. **Tree-Based Multi-Channel Protocol (TMCP)**

MODULE DESCRIPTION:

1. PERIODIC AGGREGATED CONVERGE CAST:

Data aggregation is a commonly used technique in WSN that can eliminate redundancy and minimize the number of transmissions, thus saving energy and improving network lifetime. Aggregation can be performed in many ways, such as by suppressing duplicate messages; using data compression and packet merging techniques; or taking advantage of the correlation in the sensor readings

We consider continuous monitoring applications where perfect aggregation is possible, i.e., each node is capable of aggregating all the packets received from its children as well as that generated by itself into a single packet before transmitting to its parent. The size of aggregated data transmitted by each node is constant and does not depend on the size of the raw sensor readings.

2. TRANSMISSION POWER CONTROL:

We evaluate the impact of transmission power control, multiple channels, and routing trees on the scheduling performance for both aggregated and raw-data converge cast.. Although the techniques of transmission power control and multi-channel scheduling have been well studied for eliminating interference in general wireless networks, their performances for bounding the completion of data collection in WSNs have not been explored in detail in the previous studies. The fundamental novelty of our approach lies in the extensive exploration of the efficiency of transmission power control and multichannel communication on achieving fast converge cast operations in WSNs.

3. AGGREGATED DATA COLLECTION:

We augment their scheme with a new set of rules and grow the tree hop by hop outwards from the sink. We assume that the nodes know their minimum-hop counts to sink.

4. RAW DATA COLLECTION:

The data collection rate often no longer remains limited by interference but by the topology of the network. Thus, in the final step, we construct network topologies with specific properties that help in further enhancing the rate. Our primary conclusion is that, combining these different techniques can provide an order of magnitude improvement for aggregated converge cast, and a factor of two improvement for raw-data converge cast, compared to single-channel TDMA scheduling on minimum-hop routing trees

5. TREE-BASED MULTI-CHANNEL PROTOCOL (TMCP):

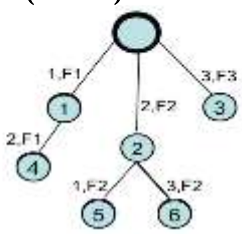
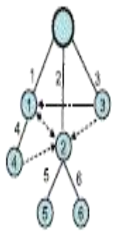


Fig: Schedule generated with TMCP

TMCP is a greedy, tree-based, multi-channel protocol for data collection applications. It partitions the network into multiple sub trees and minimizes the intra tree interference by assigning different channels to the nodes residing on different branches starting from the top to the bottom of the tree. Figure shows the same tree given in Fig. which is scheduled according to TMCP for aggregated data collection. Here, the nodes on the leftmost branch is assigned frequency F1, second branch is assigned frequency F2 and the last branch is assigned frequency F3 and after the channel assignments, time slots are assigned to the nodes with the BFS Time Slot Assignment algorithm.

ADVANTAGE:

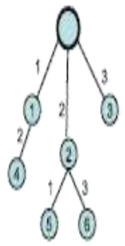
Advantage of TMCP is that it is designed to support converge cast traffic and does not require channel switching. However, contention inside the branches is not resolved since all the nodes on the same branch communicate on the same channel



(a)

	Frame 1						Frame 2					
	S1	S2	S3	S4	S5	S6	S1	S2	S3	S4	S5	S6
s	1	2	3	-	-	-	{1,4}	{2,5,6}	3	-	-	-
1	-	-	-	4	-	-	-	-	-	4	-	-
2	-	-	-	-	5	6	-	-	-	-	5	6

(b)



(c)

Fig. Aggregated convergecast and pipelining: (a) Schedule length of 6 in the presence of interfering links. (b) Node ids from which (aggregated) packets are received by their corresponding parents in each time slot over different frames. (c) Schedule length of 3 using BFS-TIMESLOTASSIGNMENT when all the interfering links are eliminated.

CONCLUSION:

In this paper, we studied fast converge cast in WSN where nodes communicate using a TDMA protocol to minimize the schedule length. We addressed the fundamental limitations due to interference and half-duplex transceivers on the nodes and explored techniques to overcome the same. We found that while transmission power control helps in reducing the schedule length, multiple channels are more effective. We also observed that node-based (RBCA) and link-based (JFTSS) channel assignment schemes are more efficient in terms of eliminating interference as compared to assigning different channels on different branches of the tree (TMCP). Once interference is completely eliminated, we proved that with half-duplex radios the achievable schedule length is lower-bounded by the maximum degree in the routing tree for aggregated converge cast, and by max $(2nk - 1, N)$ for raw-data converge cast. Using optimal converge cast scheduling algorithms, we showed that the lower bounds are achievable once a suitable routing scheme is used. Through extensive simulations, we demonstrated up to an order of magnitude reduction in the schedule length for aggregated, and a 50% reduction for raw-data converge cast. In future, we will explore scenarios with variable amounts of data and implement and evaluate the combination of the schemes considered.

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