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EFFICIENT DATA AGGREGATION AND COLLECTION IN TREE-BASED WIRELESS SENSOR NETWORKS

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Abstract: The journal investigates the following fundamental question how fast can information be collected from a wireless sensor network organized as tree? To address this, a number of different techniques using realistic simulation models under the many to one communication paradigm known as converge-cast are evaluated. Time scheduling on a single frequency channel with the plan of minimizing the number of time slots needed (schedule length) to whole a converge-cast is considered. In present system they have present Kautz graph based method, in our proposed system we use Tree based wireless sensor network system by, scheduling with transmission power control is combined to mitigate the effects of interference, and show that while power control helps in minimizing the schedule length under a single frequency, scheduling transmissions using multiple frequencies is more efficient. Converge-cast, namely the collection of data from a set of sensors toward a common sink over a tree based routing topology, is a fundamental operation in wireless sensor networks (WSN). In this journal, consider a TDMA framework and design polynomial-time heuristics to reduce the schedule length for both types of converge-cast. It also locates lower bounds on the possible schedule lengths and compares the performance of our heuristics with these bounds. Lower bounds on the schedule length are given when interference is entirely eliminated, and propose algorithms that achieve these bounds. Then, the information collection rate no longer remains restricted by interference but by the topology of the routing tree. Fast data collection with the aim to reduce the schedule length for aggregated converge-cast. It examines the impact of transmission power control and multiple frequency channels on the schedule length, where the proposed constant factor and logarithmic approximation algorithms on geometric networks (disk graphs).

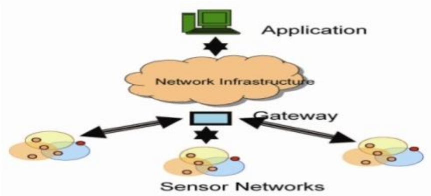
Keywords: TDMA, Converge-cast, WSN, Tree Based Wireless Sensor Network, Kautz Graph.

I. INTRODUCTION

Wireless network refers to any type of computer network that is not connected by cables of any kind. It is a method by which homes, telecommunications networks and enterprise (business) installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations. Wireless telecommunications networks are commonly implemented and administered using a communication system called broadcasting waves. This implementation takes place at the physical level (layer) of the OSI model network structure.

WIRELESS SENSOR NETWORK:

The wireless sensor network (WSN) observers the physical or environmental situations such as sound, pressure and temperature, etc. are provided by the distributed autonomous sensor; cooperatively share their information to the main location through the network. The control of sensor action is permitting through the more modern networks, such networks are bi-directional. The wireless sensor network growth is provoked for the reason of military applications such as battlefield surveillance; nowadays most of the industrial and consumer applications use such networks, it used in such cases of industrial practice and managing and monitoring, machine health and so on. The "nodes" is built by wireless sensor network (WSN) from a few to hundreds or even thousands, here; each node is linked to one particular sensor. Such sensor network node has usually a number of parts: connection to an external antenna or radio transceiver with an internal antenna, a microcontroller, an electronic path for interfacing with sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might be different in size from that of a shoebox down to the size of a grain of dust, even though functioning "motes" of genuine microscopic dimensions have yet to be formed. The cost of such sensor nodes may be variable or ranging from few to hundreds of dollars, and also depending on the individual sensor node problems. The sensor nodes results in consequent constraints on assets such as energy, memory, computational speed and communication bandwidth based on the size and cost constraints on sensor node. The topology of the WSNs can diverge from a easy star network to an complex multi hop wireless mesh network. The propagation method among the hops of the network can be routing or flooding.



In a single channel to reduce the TDMA schedule length, distributed time slot assignment method is proposed by the consideration of Raw-data Converge-cast process. The difficulty of joint scheduling and transmission power control for constant and uniform traffic demands. It presented a work which is different from the above in that the user estimate transmission power control under realistic settings and calculate lower bounds on the schedule length for tree networks with algorithms to get these bounds. The effectiveness of different channel assignment process and interference models is compared and the specific routing tree topology method is proposed to improve the information gathering rate for both aggregated and raw data converge-cast. The Aggregate converge-cast and one shot raw data converge-cast algorithms are the two converge-cast method implemented.

The minimum slot length is calculated and shown the edges in the tree that are communicated in the respective time slots. To show the network of nodes (both sink and children nodes), the windows forms in front end is graphically drawn and to simulate the time slot calculation, the BFS algorithm is applied and the time slot index value is drawn near to the nodes. The front end is used to display the time frames and data collection details in the grid also. In the back end, the 'node' table is used to save nodes id, type of node (aggregated or one-show raw data), parent node id and location in the tree details. During the frames calculation, the node id, frame number, time slot number are saved in the 'Schedule-Length' table. Relationship is set such that node id in 'node' table is used in transaction table such as 'Schedule-Length'. In this theory, it considers such applications and focus on the following fundamental question: "How fast can information are flowed from a set of sensors to a sink over a tree- based topology?" this thesis consist two types of data collection:

- ➢ The bundles are aggregated to each hop in the aggregated converge-cast and
- ➢ The bundles are freely moved toward the sink in the Raw-data converge-cast. The aggregated converge-cast is valid only a strong correlation is present in the data, or the aim is to collect summarized information such as maximum sensor reading.

Raw data converge-cast, alternatively, is applicable when every sensor reading is equally significant, or the correlation is least. The proposed system focuses on aggregated converge-cast in the context of continuous information collection, and the raw data converge-cast for one-shot data collection. These two types keep up a correspondence to two extreme cases of data collection. In a previous work, the complexity of applying various aggregation factors, i.e., information compression factors, was considered, and the latency of data collection was shown to be within the performance bounds of the two strict cases of no information compression and full information compression. For periodic traffic, it is well recognized that contention-free medium access control (MAC) procedures such as TDMA (Time Division Multiple Access) are enhanced fit for quick data collection, since they can remove collisions and retransmissions and offer guarantee on the completion time as opposed to contention-based protocols.

However, the difficulty of constructing conflict free (interference-free) TDMA schedules even under the simple graph based interference model has been proved to be NP-complete. In this theory, it considers a TDMA framework and plan polynomial-time heuristics to reduce the schedule length for both types of converge-cast. It also gets lower bounds on the achievable schedule lengths and evaluates the performance of the heuristics with these bounds. It starts by recognizing the primary limiting factors of fast information collection, which are:

- ➢ Interference may occurs in the wireless medium,
- ➢ In the sensor nodes the Half-duplex transceivers are provided, and
- ➢ Topology of the network.

Then, it investigates a number of various methods that provide a hierarchy of successive improvements, the simplest between which is an interference-aware, minimum-length, TDMA scheduling that enables spatial reuse. To get further improvement, it combines transmission power control with scheduling, and use various frequency channels to permit more concurrent transmissions.

II. RELATED WORK

In the paper "Spanning tree based algorithms for low latency and energy efficient data aggregation enhanced converge-cast (DAC) in wireless sensor networks" [4] the authors S. Upadhyayula and S.K.S. Gupta stated that Many wireless sensor networks (WSNs) employ battery-powered sensor nodes. Communication in such networks is very taxing on its scarce energy resources. Converge-cast method of routing data from many bases to a sink is usually performed action in WSNs. Data aggregation is a regularly used energy conversing method in WSNs. The rationale is to decrease volume of communicated data by using in network processing ability at sensor nodes. In that paper, they represents the difficulty of performing the process of data aggregation enhanced converge-cast (DAC) in an energy and latency efficient means.

They assumed that all the nodes in the system have a data item and there is an a priori known function dependent data compression feature (or compression factor), c, that approximates the practical fraction of the total data composed. The paper first presentS two DAC tree construction algorithms. One is a variant of the Minimum Spanning Tree (MST) algorithm and the other is a variant of the Single Source Shortest Path Spanning Tree (SPT) algorithm. These two algorithms provide as a motivation for our combined algorithm (COM) which generalized the SPT and MST based algorithm. The COM algorithm tries to build an energy optimal DAC tree for any fixed value of α (= 1 - У), the information growth factor. The nodes of these trees are scheduled for collision-free interaction using a channel allocation algorithm. To achieve low latency, these algorithms use the b-constraint, which puts a soft edge on the greatest number of children a node can have in a DAC tree.

The DAC tree achieved from energy minimizing phase of tree construction algorithms is reorganized using the β-constraint to decrease latency (at the expense of rising energy cost). The effectiveness of these algorithms is estimated by using energy efficiency, latency and network lifetime as metrics. With these metrics, the algorithms' performance is compared with an existing data aggregation technique. From the experimental results, for a given network density and data compression factor c at intermediate nodes, one can choose an appropriate algorithm depending upon whether the primary goal is to minimize the latency or the energy consumption. One important function of many wireless sensor networks (WSNs) is to gather data from hostile or remote environments. It is expected of such networks to work untended for a long duration. Due to limited energy resources, the above requirements put constraints on the energy usage. Investigative various functionalities of sensor networks, communication can be singled out as one function that devours big share of the energy resources. A review of the literature suggests that many attempts have been made to minimize energy consumption during communication [6–12]. The process of routing data from all the nodes to one node (called a sink node) is called a converge-cast. In WSNs the energy cost for transmitting data far exceeds the cost of processing it [13]. Data aggregation is an energy management method which tries to reduce the amount of information communicated by gathering local information at intermediate nodes and forwarding only the result of an aggregation process, such as min and max, towards the sink node.

In the paper "The Worst-Case Capacity of Wireless Sensor Networks" [5] the author Thomas Moscibroda stated that the key application scenario of wireless sensor networks is data gathering: sensor nodes transmit data, possibly in a multi-hop fashion, to an information sink. The performance of sensor networks is thus characterized by the rate at which information can be aggregated to the sink. In the paper, they derived the first scaling laws describing the achievable rate in worst-case, i.e. arbitrarily deployed, sensor networks. They showed that in the physical model of wireless communication and for a large number of practically important functions, a sustainable rate of $\Omega(1/\log 2n)$ can be achieved in every network, even when nodes are positioned in a worst-case manner. In contrast, we show that the best possible rate in the protocol model is $\Theta(1/n)$, which establishes an exponential gap between these two standard models of wireless communication. Furthermore, their worst-case capacity result almost matches the rate of $\Theta(1/\log n)$ that can be achieved in randomly deployed networks. The high rate is made possible by employing non-linear power assignment at nodes and by exploiting SINR-effects. Finally, their algorithm also improved the best known bounds on the scheduling complexity in wireless networks.

III. BACKGROUND STUDY

PROBLEMS IN PRESENT SYSTEM

The performance of a sensor network can therefore be characterized by the rate at which data can be aggregated and transmitted to the information sink. In particular, the theoretical measure that captures the possibilities and limitations of information processing in sensor networks is the many-to-one data aggregation capacity, or its inverse, the maximum sustainable rate (bit/s) at which each sensor node can continuously transmit data to the sink. Given the fundamental importance of this "computational throughput capacity" in sensor networks it is not surprising that there already exists a rich literature that deals with scaling laws for the achievable data aggregation rate in wireless sensor networks under various models and for different functions. First and foremost, they initiated the study of the worst- case capacity of sensor networks. Starting from the seminal work of Gupta and Kumar, scaling laws on the capacity in wireless networks have been almost exclusively derived making assumptions regarding the placement of the nodes in the network.

The standard assumption is that nodes are either located on a grid-like regular structure, or else are randomly and uniformly distributed in the plane following a certain density function. In contrast, they advocated studying scaling laws that capture the achievable rate in worst-case, i.e., arbitrarily deployed sensor networks. This novel notion of worst-case capacity concerns the query of how much information can each node transmit to the source, regardless of the network's topology. The motivation for studying arbitrary node distributions stems from the following practical consideration. Many sensor networks feature heterogeneous node densities and there are numerous application scenarios—for instance networks deployed indoors, or along a road where node placement contains or resembles typical "worst-case" structures such as chains. Studying the worst-case capacity of wireless networks therefore offers an exciting alternative to the idealized capacity studies conducted so far. One criticism that worst-case analysis is frequently confronted with is that it tends to focus on oversimplified models for wireless communication in order to keep the analysis concise enough for stringent proofs. And indeed, algorithmic work on data gathering and the many-to-one communication problem has been based on simplified protocol or graph-based models.

The main objective of the system analysis is to study the existing operation and to learn and accomplish the processing activities. The fast data collection process in wireless sensor network is needed to be analyzed well. The details are processed through data structure concept especially using tree structure. The feasibility study deals with all the analysis that takes up in developing the project. Each structure has to be thought of in the developing of the project, as it has to serve the end user in a user-friendly manner. One must know the type of information to be gathered and the system analysis consist of collecting, organizing and evaluating facts about a system and its environment. The problem of minimizing the schedule length for raw-data converge-cast on single channel is shown to be NP (Non-Deterministic Polynomial Time)-complete on general. Maximizing the throughput of converge-cast by discover a shortest length, conflict free schedule. Rich a greedy graph coloring policy allocate time slots to the senders and prevents obstruction. The impact of routing trees on the schedule length are considered and proposed a routing system called disjoint strips to transmit data over various shortest paths. However, since the sink remains as the bottleneck, sending information over various paths does not decrease the schedule length.

For instance, in safety and mission critical functions where sensor nodes are deployed to identify oil/gas leak or structural damage, the actuators and controllers require receiving information from all the sensors within a particular deadline, failure of which might lead to unpredictable and catastrophic events. This falls under the group of one shot information gathering. On the other hand, applications such as permafrost monitoring need periodic and fast information delivery over long periods of time, which falls under the group of continuous data collection.

For periodic traffic, it is well recognized that conflict free medium access control (MAC) procedure such as TDMA (Time Division Multiple Access) are enhanced fit for fast information collection, since they can remove collisions and retransmissions and offer guarantee on the completion time as opposed to contention based procedures. However, the problem of making conflict-free (interference-free) TDMA schedules even under the simple graph based interference model has been confirmed to be NP-complete. In this project, consider a TDMA framework and plan polynomial time heuristics to reduce the schedule length for both types of converge-cast. It also finds lower bounds on the achievable schedule lengths and evaluates the performance of our heuristics with these bounds. The difficulty of joint scheduling and transmission power manage for constant and uniform traffic demands. It can be conquer by Aggregate converge cast and One Shot Raw Data converge cast algorithms.

IV. PROPOSED METHODOLOGY

The proposed system introduces polynomial-time heuristics for TDMA scheduling for both types of data collection, i.e., Algorithms (BFS-Time Slot Assignment) and (Local Time Slot Assignment), prove that they do achieve the lower bound of data collection time once interference is eliminated. **Bounds on Converge-cast Scheduling:** The proposed system shows that if all intrusive links are removed, the schedule length for aggregated converge-cast is lower bounded by the greatest node degree in the routing tree, and for raw-data converge-cast by max(2nk −1,N), where nk is the maximum number of nodes on any branch in the tree, and N is the number of source nodes. It then establishes optimal time slot assignment methods under this scenario which get these lower bounds.

The proposed system shows the enhancement due to the routing organization comes from using capacitated minimal spanning trees for raw data converge-cast, where the number of nodes in a sub-tree is no more than half the total number of nodes in the remaining sub-trees. In the proposed system, the sink node (root node of the logical tree) collects the data (both aggregated converge-cast and one shot raw data packets) from the children nodes each type at regular intervals. The children nodes responsible for collecting aggregated data or individual packet data will send those packets upwards in discrete manner with toggle mechanism. Suppose, the wireless nodes fixed in a pipe line needs to send aggregated packet data (data collected at same pipe line) as well as needs to send individual packet data (data collected at branch pipe toggle data collection options so that communicate would be better. This can be achieved if both the sink node and children nodes are added up with buffers so that two kinds of data packets can be kept in memory. This will eliminate the requirement of fitting two wireless nodes in same place to collect two different kinds of data packets.

The continuous monitoring applications are considered 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 broadcasting to its parent. The size of aggregated data transmitted by every node is constant and does not depend on the size of the raw sensor readings. Typical examples of such aggregation functions are MIN, MAX, MEDIAN, COUNT, AVERAGE, etc. The notion of pipelining in aggregated converge-cast and that of a schedule length on a network of 6 source nodes is illustrated. The solid line signifies tree edges, and the dotted lines stand for interfering connections. The numbers beside the links represent the time slots at which the links are scheduled to transmit, and the numbers inside the circles denote node id's. The entries in the table list the nodes from which packets are received by their corresponding receivers in each time slot. We note that at the end of frame 1, the sink does not have packets from nodes 5 and 6; however, as the schedule is repeated, it receives aggregated packets from 2, 5, and 6 in slot 2 of the next frame. Similarly, the sink also receives aggregated packets from nodes 1 and 4 starting from slot 1 of frame 2. In this technique, a time slot assignment method in Algorithm 1, called BFS-TIMESLOTASSIGNMENT is planned, that get this bound. In each iteration of BFS-TIMESLOTASSIGNMENT, an edge e is selected in the Breadth First Search (BFS) order starting from any node, and is allocated the minimum time slot that is different from all its adjacent edges regarding interfering constraints.

Note that, if the interfering connections are exists, the related constraint in line 4 is checked; however, when interference is eliminated this check is redundant. The algorithm reduces the schedule length when there are no interfering links, as proved in Theorem 1. To demonstrate, the same network with all the interfering connections removed, and so the network is scheduled in 3 time slots.

Even though BFS- TIMESLOTASSIGNMENT cannot be assessment to perfect scheduling under the physical intrusion model, it is a heuristic that can attain the lower bound if all the interfering connections are removed. Consequently, together with a technique to eliminate interference the algorithm can optimally schedule the network.

Algorithm 1:

1. Input: T =(V, E_T)
2. While ET = £ do
3. e ← next edge from E_T in BFS order
4. Assign minimum time slot t to edge e regarding adjacency and nosy constraints
5. E_T ← E_T \{e}
6. End while

ONE-SHOT RAW-DATA CONVERGECAST

In this technique, one shot data collection is considered where every sensor analysis is equally significant, and so aggregation may not be attractive or even possible. Thus each of the bundles has to be independently scheduled at each hop en route to the sink.

Unlike in the case of periodic collective converge-cast where a pipelining takes place and each of the tree edges is listed only once within each frame, here the edges could be planned numerous times and there is no pipelining.

A time slot assignment technique in Algorithm 2, called LOCAL-TIMESLOTASSIGNMENT is illustrated, which is run close by each node at every time slot. The key idea is to:

(i) Schedule communications in parallel on many branches of the tree, and

(ii) Keep the sink busy in getting packets for as many time slots as possible.

Because the sink can receive from the root of at most one top sub-tree in any time slot, which top sub-tree should be made active is need to be decided. Assuming that the sink is aware of the number of nodes in each top sub-tree, each source node maintains a buffer and its associated state, which can be either full or empty depending on whether it provides a bundle or not. The algorithm does not need any of the nodes to store more than one packet in their buffer at any time. All the buffers are initialized as full, and assume that the sink's buffer is always full for the ease of explanation.

Algorithm 2: LOCAL-TIMESLOTASSIGNMENT

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

The first block of the algorithm in lines 2-4 provides the scheduling rules among the sink and the roots of the top sub-trees. A top sub-tree is defined to be suitable if its root has at least one packet to transmit. For a given time slot, the root of an eligible top sub-tree is scheduled which has the largest number of total (remaining) packets. If none of the top sub-trees are qualified, the sink does not obtain any packet during that time slot. Inside each top sub-tree, nodes are scheduled according to the policy in lines 5-12. A sub-tree is defined to be active if there are still packets left in the sub-tree (excluding its root) to be relayed. If a node's buffer is empty and the sub-tree rooted at this node is active, one of its children is scheduled at random whose buffer is not empty. The algorithm guarantees (as proved in Lemma 3) that in an active sub-tree there will always be at least one child whose buffer is not empty, and so whenever a node empties its buffer, it will receive a packet in the next time slot, thus emptying buffers from the bottom of the sub-tree to the top.

In the first time slot, since the qualified top sub-tree containing the largest quantity of remaining packets is {2, 5, 6}, we schedule the connection (2,s), and the sink receives a packet from node 2 in slot 1. In the second time slot, the suitable top sub-trees are {1, 4} and {3, 7}, both of which have 2 remaining packets. Choose one of them at random, say {1, 4}, and schedule the link (1,s). Also, in the same time slot since node 2's buffer is empty, it chooses one of its children at random, say node 5, and schedule the link (5, 2).In the third time slot, the eligible top sub-trees are {2, 5, 6} and {3, 7}, both of which have 2 remaining packets. Choose the first one at random and schedule the link (2,s), and so the sink receives node 5's packet (relayed by node 2). We also schedule the link (4, 1) in the third time slot because node 1's buffer is empty at this point. This process continues until all the packets are delivered to the sink, yielding an assignment that requires 7 time slots. Note that, in this example, $2nk - 1=5$, and so $\max(2_{nk}-1,N)=7$.

V. RESULTS AND DISCUSSION

The scheduling problem is considered where packets are aggregated. 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.

VI.CONCLUSION

In this application, speedy converge-cast in WSN where nodes are in touch using a TDMA protocol to reduce the schedule length is considered. The system addressed the fundamental restrictions due to interference and half-duplex transceivers on the nodes and explored method to overcome the same. It is found that while broadcast power control helps in reducing the schedule length, multiple channels are more efficient. Once interference is totally eliminated, the project confirms 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 information converge-cast. Using converge-cast scheduling algorithms, the time slot length is reduced much.

The proposed system presents a way to blend additional information into a fast data collection mechanism in minimum time slot length. It provides a best assistance in data collection in wireless sensor nodes. The following facilities can be added in future

- ✓ The application can be designed as a web site so that it can be accessed across the platforms.
- ✓ The algorithms if developed as web service, then many applications make use of the concept.

In future, the application can explore scenarios with variable amounts of data, implement and evaluate the impact of routing trees in data collection. The new system becomes useful if the above enhancements are made in future. The new system is designed such that those enhancements can be integrated with current modules easily with less integration work.

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