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ENERGY CONSUMPTION AND END-TO-END DELAY CONSTRAINED PROBLEMS IN SENSOR NETWORKS

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Abstract— In sensor networks various inter domain and exterior domain-based nodes are communicated and multiple nodes are exchanges packets simultaneously. The investigation reports studied the problem of jointly optimizing energy rate is high and delay constrained also increased in existing works.
Keywords— Introduction, MEM Problem, MEB Problems, DeMEM, DeMET.

I. INTRODUCTION

The majority of the nodes are suffered with battery power is a key problem of energy cost reduction in wireless sensor network is to find route with minimum total energy consumption for a given communication session.

II. RELATED WORK

In Existing Work, the problem of transmitting energy consumption optimization is referred to a Minimum-Energy Multicast (MEM) problem, and has been extensively studied in static networks. Since both Minimum Energy Multicast problem and Minimum- Energy Broadcast (MEB) problem, a special case of MEM, are proven to be NP-hard, then the people focuses on designing efficient results. **Wieselthier et al**. study the Minimum Energy Multicast problem using the same approach as the Minimum Energy Broadcast problem and propose three greedy heuristics. **Wan et al.** prove that both problems can be approximated within constant ratio. **Liang et al.** propose approximation algorithms for Minimum Energy Broadcast problem where the nodes have different transmission power levels. **Gong et al.** propose an efficient distributed algorithm for multicast tree construction in wireless Sensor Network. However, as noted earlier, prior literature only focuses on the minimization of transmitting energy, relies on the assumption that the receiving energy is directly proportional to the number of receivers or considers the receiving energy in the context of network-wide broadcast.

In contrast, the proposed framework in our work jointly minimizes the transmitting and receiving energy, with applicability to more general scenarios. The major limitations are there is no Accurate Less Energy Node detection due to absence of filtering techniques. More packets drops frequently.

III. PROPOSED WORK

The Proposed Work, formulated our problem called solution for energy consumption and end-to-end delay constrained problems in sensor networks using DMET scheme for optimizing the problem and the approximation ratio of polynomial distribution-based algorithm for NP-hardness issues, which yields to improve energy and delay constrained problems.

CONTRUBUTION OF WORK

In contribution work several prospective directions that are explored based on the present work: First, it streams the packets that need to be sent multiple users using proposed scheme. Second, the proposed algorithm works on centralized and distributed based assumption used that node mobility exactly considered. Third Multiple transmissions at each timeslot are regularized. **Finally, this Study extensively results,** to improve both network performance measurement with feasibility with given power consumption levels are finite.

IV. PROPOSED RELATED WORK

A. Multicast Model

We consider a wireless multicast session with a source S ε V and destination nodes set T ⊆ V in mobile network *G*. Therefore, for a multicast session, we only need to consider the network snapshots within the delay constraint. Hence, in the sequel, we truncate the mobile network G into D static graphs denoted as {G1,G2, . . .,GD}. Since we aim to design a minimum energy transmission scheme for a delay-constrained multicast session in a mobile wireless network, we next formally define the notion of transmission scheme. We refer to the process of some transmitter transmitting message to the intended receivers as a transmission. A transmission scheme specifies the transmitter, intended receivers, timing and transmission power of each transmission.

***Definition 1*:** A transmission scheme V Å~ 2V Å~ {1, . . .,D}Å~R+ is a sequence of tuples {(*u, V, t, p*)}, where a tuple τ = *(uτ , Vτ , tτ , pτ)*denotes that node u_ should transmit to the nodes in *V* at time slot *t* with power *p* . Also, in a transmission scheme _, we define a node to be "reached in time slot *t*" in a recursive way as follows: the source *s* is reached in time slot 1,

i. if a node is reached in time slot t, then it is reached in time slot t_ for all *t*, and
ii. if a node u is reached in time slot t and (*u, V, t, p*), then all nodes in *V* are reached after time slot *t*, or we say they have been reached in time slot t + 1.

Now, we give the definition of feasible transmission scheme and will restrict our consideration to the set of feasible transmission schemes in the sequel. Intuitively, a scheme is said to be feasible if it is without redundancy and qualified for the delay constrained multicast session.

B. Energy Model

For a transmission specified by tuple *τ = (uτ , Vτ , tτ , pτ),* we model the energy consumption of this transmission as

$$E(\tau) = p\tau + f(|V\tau|), \quad \ldots\ldots(1)$$

where the first part denotes the energy consumed by the transmitter side and f is a function of the number of intended receivers that can represent the receiving energy. Note that our framework does not restrict to any specific f and the choice of f may depend on practical settings [7], [9], which will be specified in Section VI. It follows that the energy consumption of a transmission scheme π is given by:

$$E(\pi) = E(\tau).\tau\in\pi \quad \ldots\ldots(2)$$

Now we formulate the DeMEM problem as follows.

C. The DeMEM Problem

Given a mobile wire- less network *G = G1, G2,... , GD* , a source node s, a set T of destination nodes, and a delay constraint D, the goal is to find a feasible transmission scheme with minimum energy consumption.

We note that in the definitions above, we make the following characterizations of communication in mobile wireless networks. First, we assume that the transmission rate is much faster than that of the nodes' mobility. Second, we can utilize the wireless broadcast nature during communications, i.e., different nodes can be reached within one transmission as long as the transmission power is large enough. Third, in the present work, we focus on the multicast of one data packet in the network, which alleviates us from the burden of interference and packet scheduling issues. We leave the minimum energy multicast with a streaming of packets as future work.

D. Approximation Hardness

In this section we analyse the approximation hardness of DeMEM problem. We show that even without receiving energy (i.e., f = 0), the DeMEM problem cannot be approximated within a text coloured logarithmic factor in polynomial time by reduction from acyclic directed Steiner tree problem.

Lemma 1

There exists an algorithm that provides an l(l 1)k l approximation to Steiner tree problem in directed graph in time O(nlkl+n2k+nm) where n is the number of vertices, k is the number of terminals and m is the number of edges. Specifically, set l = log k, we get an 2 log2 k approximation in time O((nk)log k) [35], [37]. Through implementation of the Steiner tree algorithm, we obtain an approximate Steiner tree in our intermediate graph, which will serve as the basis for the construction of transmission scheme.

E. Mapping into the Transmission Scheme

Based on the algorithm we computed, we proceed to design the corresponding transmission scheme. First, we present a difficult property of the changed process.

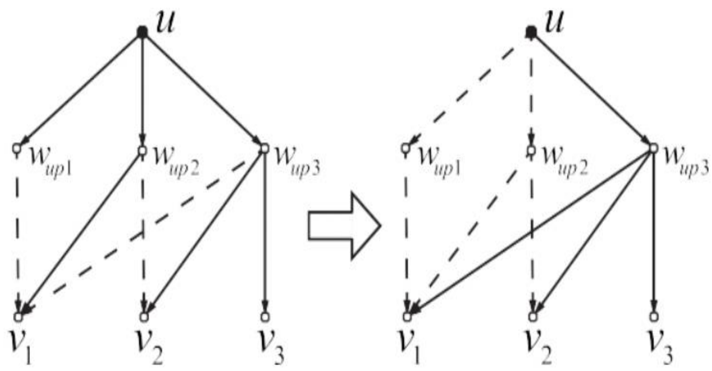


Fig. 1.Illustration of the pruning procedure in ConMap without receiving energy. The left part denotes a subgraph of a constructed Steiner tree that is not in canonical form. The right part represents the corresponding subgraph after the pruning procedure: absorb the original vertices that are connected to wup2 into wup3. And the solid lines are the way that we have chosen to transmit and the dashed lines present the way that we have not chosen.

Lemma 2

For an instance of DeMEM problem, let *i* be the directed Steiner tree instance converted from by ConMap framework. Each feasible transmission scheme in corresponds to a valid Steiner tree in i, and the energy consumption of the scheme equals to the cost of its corresponding Steiner tree.

Proof

We describe a procedure that maps a feasible transmission scheme π for to an edges set ET that forms a tree based logic for i. For each tuple (u, V i, t, p) π, we add the edge from u to the power level corresponding to p in layer Lt together with the edges from the aforementioned power level to the original vertices of vertices in V i of Lt into ET . Finally, we add the necessary inter-layer edges into the set. The edge set constructed by the above procedure will be a valid Steiner tree for i. In the sequel, we refer to the Steiner trees that have corresponding transmission schemes as being in canonical form.

From the proof of Lemma 2, we note that the energy consumption of any scheme is no less than the cost of the optimal Steiner tree in the constructed instance. Therefore, a transmission strategy mapped from an a-optimal Steiner tree is guaranteed to be an a-optimal transmission scheme. However, the Steiner tree computed in the intermediate graph may exhibit "aberrant phenomena" so that it has no corresponding feasible transmission scheme. Hence, in the final phase of ConMap, before we map our computed tree back into a transmission scheme, we need to prune it into canonical form.

The possible aberrant phenomena that can cause a Steiner tree ET not to have its corresponding feasible transmission scheme is: there are edges from different power levels to multiple original vertices that correspond to the same network node, leading to decrease transmissions. To deal with this case we keep the edge with the original vertex in the earliest time slot and delete other redundant edges. An example of the pruning procedure is illustrated in Figure 2. Then, we add necessary inter-layer edges to reconnect the resulting edge set into a Steiner tree. Note that the above two procedures do not increase the cost of the resulting Steiner tree. Therefore, the pruned tree can only be closer to optimal. After describing the three main stages of the framework, we summarize Converting Map in Algorithm 1.

1. Proposed Algorithms

Illustration of ConMap Using frame work of DeMEM, Now we illustrate our proposed framework, Converting Map, using an example of a five-node mobile network, where

Algorithm 1 Converting Map Steiner Framework for DeMEM

Input: An instance of the DeMEM problem

Output: A transmission scheme π for

1: Construct the corresponding intermediate graph of and form an instance of directed Steiner tree *i*.

2: Compute a (approximate) minimum Steiner tree ET in for *i*.

3: Prune ET into canonical form.

4: Convert the pruned ET to its corresponding transmission scheme π for M.

2. Performance Analysis of DMET

We proceed to provide analysis on the performance of the Converting Map framework in terms of running time and approximation ratio. Without loss of generality, we assume the approximation guarantee of embedded algorithms for directed Steiner tree only depends on the number of terminals in the graph [3,4], [3,5].

Theorem 2

For a sensor network with n nodes, let k be the number of destinations and D be the delay constraint. Suppose the directed Steiner tree algorithm embedded in Converting Map runs in (V, E, k) time and achieves an approximation ratio of g(k) on graph G(V, E). If we only consider the transmitting energy, then Converting Map returns a transmission scheme of which the energy cost is less than g(k) times the optimal one in time O((Dn2, Dn3)).

Proof

First, we focus on the time complexity of Converting Map. In the first phase, since there are at most (n 1) power levels for each node and the intermediate graph contains D layers, it takes a time of O(Dn3) to construct such an intermediate graph. Note that the intermediate graph has at most Dn2 vertices and Dn3 edges. Hence, the time complexity of phase 2 is O((Dn2, Dn3)). As for phase 3, the pruning and the converting process can both be done by traversing the tree, which takes O(Dn3) time. Hence, the total running time is O((Dn2, Dn3)). Obviously the approximation ratio of the whole framework is determined by the second phase. By Lemma 2 and the fact that the number of terminals in the intermediate graph equals to the number of destinations we conclude that the approximation ratio of the proposed framework well preserves that obtained under the Steiner tree algorithm. Now we give a concrete instantiation of our ConMap framework. If we embed the approximation algorithm for directed Steiner tree in [35], then we have a procedure that runs in O((Dn2k)log k) time and returns a transmission scheme that is within a 2 log2 k factor of the optimal one.

(i) Construction of Intermediate Graph

The main idea lies in that instead of adding a simple edge from each power level of transmitters to their receivers, we create gadgets in the intermediate graph that charges the trees for the cost corresponding to receiving energy. For a power level of original vertex u that covers k receiving nodes v1, v2,... , vk, the construction of the gadget is as follows. First, we create k rows of new vertices, with each row containing k vertices, which, in the sequel, will be referred to as “virtual vertices”. We denote the vertices in row i as vi1, vi2,... , vik. Second, we add a zero-weight edge from each virtual vertex to its corresponding receiving node (e.g, from v11, v21,..., vk1 to v1). Then, for the virtual vertices in two adjacent rows, we insert edges between them such that the subgraph formed by the nodes in each two adjacent rows is a complete bipartite graph. The direction of these edges is from the row with lower index to the row with higher index. And we set the weights of all the edges between row i and row i +1 as f (i + 1) f (i). Finally, we add edges from vp to all the virtual vertices in the first row and set their weights as f (1). An example of the gadget is shown in Figure 2.

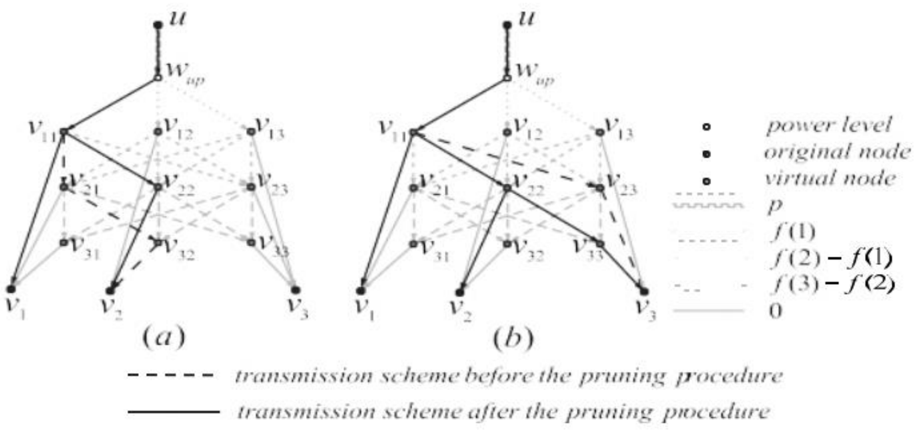
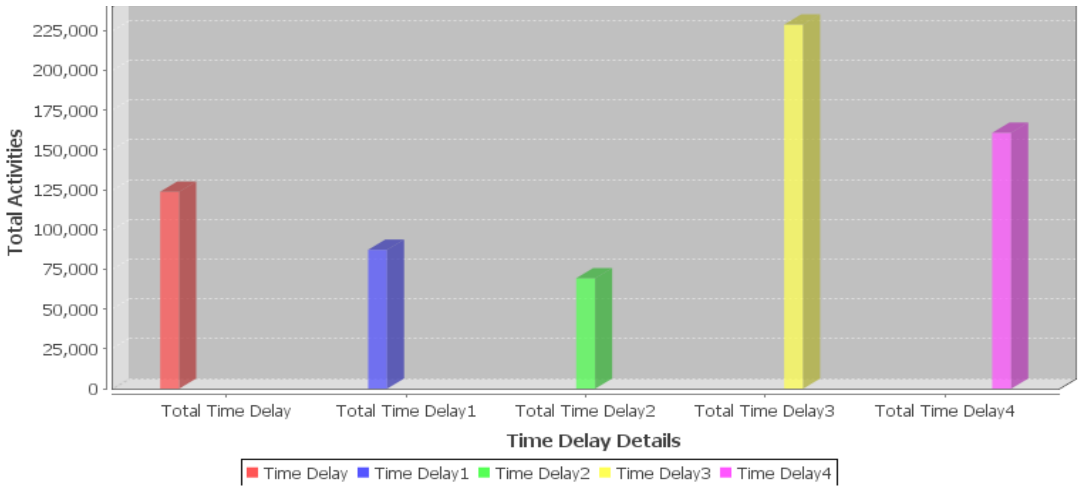


Fig 2. Implementation of two pruning process to construct intermediate graph.

V. Comparative Results



VI. Conclusions

In this paper first, it will be interesting to take into account the streaming of packets that need to be sent. In this way, it can be text coloured foreseen that during transmission one also needs to consider scheduling later packets in the stream; Second, the proposed algorithm is centralized, based on the assumption that node mobility is known exactly a priori. Last but not least, the incorporation of interference into the model is also likely to bring about different results, especially when we consider multiple transmissions at each time slot.

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