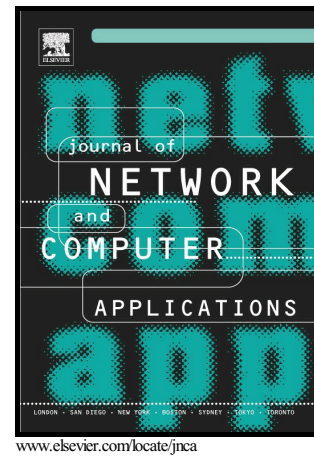


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Delay Constrained Relay Node Placement in Two-tiered Wireless Sensor Networks: A Set-Covering-based Algorithm

Chaofan Ma^{a,b,c}, Wei Liang^{a,b}, Meng Zheng^{a,b}

^aShenyang Institute of Automation, Chinese Academy of Sciences, Shenyang 110016, China.

^bState Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang 110016, China.

^cThe University of Chinese Academy of Sciences, Beijing 100049, China.

Abstract

As Wireless Sensor Networks (WSNs) are widely used in time-critical applications, e.g., factory automation and smart grid, the importance of Delay Constrained Relay Node Placement (DCRNP) problem is becoming increasingly noticeable. Considering the benefits in terms of energy efficiency and scalability brought by the two-tiered topology, this paper studies the DCRNP problem in two-tiered WSNs. To address the NP-hardness, a Two-phase Set-Covering-based Algorithm (TSCA) is proposed to approximately solve this problem. To be specific, in the first phase, a Connectivity-aware Covering Algorithm (CCA) places Relay Nodes (RNs) to fully cover distributed sensor nodes with respect to delay constraints, and meanwhile CCA tries to reduce the number of connected components in the topology constructed in this phase so as to save the RNs deployed to build network connectivity. In the second phase, the network connectivity is built in obedience to delay constraints by a Set-Covering-based Algorithm (SCA) through an iterative manner, which formulates the deployment of RNs at each iteration as the set covering problem and solves this problem using a classic set covering algorithm. In addition, the elaborated analysis of time complexity and approximation ratio of the proposed algorithms is given out. Finally, extensive simulations demonstrate that TSCA can significantly save deployed RNs in comparison to existing algorithms.

Keywords: Wireless sensor networks, set cover, delay, relay node placement, approximation algorithm

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