

CITY UNIVERSITY OF HONG KONG  
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Dynamic Multi-resolution Data Dissemination  
and Minimum-Latency Information  
Propagation in Wireless Sensor Networks  
無線傳感器網絡中動態速率請求下能量高  
效的数据分发与最小延时的信息傳播调度  
算法研究

Submitted to  
Department of Computer Science  
電腦科學系  
in Partial Fulfillment of the Requirements  
for the Degree of Doctor Philosophy  
哲學博士學位

by

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September 2008  
二零零八年九月

# ABSTRACT

Recent years have witnessed the deployments of wireless sensor networks (WSNs) in a wide range of applications, which include the data-intensive applications gathering the information about physical environments, and mission-critical applications propagating time-critical information throughout the network. A key requirement of these data-gathering WSNs is to deliver the information about dynamic physical phenomena to users at multiple temporal resolutions. The major objective of applications in the other category is to bound the worst-case latency of propagating a message from any node to all other nodes in the network. Motivated by these two kinds of WSN applications, we investigate the issues of energy-efficient data dissemination and time-efficient broadcast scheduling in this thesis. The major work of the thesis can be summarized as follows.

First, we propose a novel solution called the Minimum Incremental Dissemination Tree (MIDT) for dynamic multi-resolution data dissemination in WSNs. MIDT includes an online tree construction algorithm with an analytical performance bound and two lightweight tree adaptation heuristics for handling data requests with dynamic temporal resolutions. Our simulations based on realistic settings of Mica2 motes show that MIDT outperforms several typical data dissemination schemes. The two tree adaptation heuristics can effectively maintain desirable energy efficiency of the dissemination tree while reducing the overhead of tree reconfigurations under representative traffic patterns in WSNs.

Second, we formulate the Minimum-Latency Information Propagation (MLIP) problem under the general protocol interference model, whose objective is to bound the worst-case latency of propagating a message from any node to all other nodes in the network while minimizing the storage or communication overhead. We propose a novel solution called the Virtual Backbone-based Scheduling (VBS), which includes efficient TDMA-based centralized and distributed scheduling algorithms of constant approximation in terms of message propagation latency. Both theoretical analysis and extensive simulation results show that our algorithms can achieve desirable latency and overhead compared to existing broadcast scheduling algorithms.

Finally, we study the TDMA-based scheduling problem of two fundamental communications in wireless ad hoc networks, which include the Local Broadcast Scheduling (LBS) and Global Broadcast Scheduling (GBS), and establish their scheduling complexities under the physical interference model. For each communication model, we propose a constant approximation algorithm and a more efficient heuristic with performance evaluation by extensive simulations. In particular, for the LBS problem, we propose a lightweight randomized algorithm with the latency at most a logarithmic factor relative to the optimal solution, where nodes can wake up asynchronously, and its practical performance is comparable with our best centralized algorithm.

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