ENERGY-EFFICIENT CHANNEL ACCESS AND ROUTING PROTOCOLS FOR MULTI-HOP WIRELESS NETWORKS

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ABSTRACT

Recent research efforts on multi-hop wireless networks are motivated and driven by two important phenomena: an ever increasing demand for ubiquitous access to online information and services, and a strong desire and need to capture and analyze data from physical phenomena surrounding us in our daily lives. The first of the two constitutes an inspiration for *wireless mesh networks*, as the latter does for *wireless sensor networks*.

In this thesis, we address the energy-efficient media access control (MAC) and routing issues on multi-hop wireless networks. Our major contributions are threefold. First, we propose a set of contention-free MAC protocols that do not rely on global time synchronization and that are possessed of the desired characteristics of a multi-hop wireless network protocol; i.e. they are *energy-saving*, *distributed*, and *self-stabilizing*. Our protocols attest that distributed and asynchronous slot assignment with reasonable frame sizes and throughput is possible in multi-hop wireless networks.

Second, we present the first routing protocols that -to the best of our knowledge- improve the QoS level of Spatial TDMA (STDMA) MAC protocols by effectively decreasing the end-to-end delay in wireless sensor and mesh networks. In large multi-hop wireless networks, where data is routed over several hops, the end-to-end latency may be significantly large, especially when a reservation-based channel access protocol is used. We show that by exploiting the relative timing of nodes' slots in the underlying STDMA protocol, significant performance gain is possible compared to the shortest-hop based conventional routing approaches.

Third, we propose a general framework for a new hybrid media access scheme based on the idea of *spatially limiting* the contention in multi-hop wireless networks. The channel assignment component of the hybrid access scheme employs a novel approach for carefully selecting the set of contending nodes such that the *hidden terminals* are completely eliminated. Hence, in the contention-based component of the hybrid access scheme, only the spatially close (neighbor) nodes contend for the

channel as if in a single-hop network, which can be handled much more efficiently by a carrier-sense multiple access (CSMA) scheme. In order to assess the performance of the proposed scheme under different network conditions, we provide and utilize a general framework for the formal analysis of CSMA and CSMA/CA (collision avoidance) schemes for multi-hop wireless networks, which can capture *under-saturation* traffic loads unlike prior work.