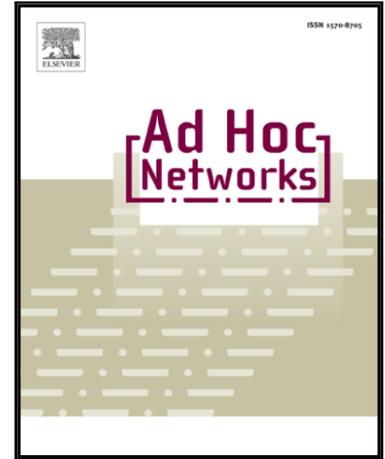


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# Flexible Real-time Transmission Scheduling for Wireless Networks with Non-deterministic Workloads

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## Abstract

Wireless Sensor Networks (WSNs) are increasingly used in industrial applications such as the Internet-of-Things, Smart City technologies and critical infrastructure monitoring. Industrial WSNs often operate in a cluster or star configuration. To ensure real-time and predictable performance link access is typically managed using time-slotted superframe methods. These methods generally use static and potentially inefficient slot assignments. In this paper, we propose to dynamically readjust time slot lengths as a technique to minimize overall energy consumption. Our approach combines real-time performance guarantees with energy conservation methods through a set of dynamic modulation based adaptive packet transmission scheduling algorithms that are designed to *reclaim* unused slot times. To support our reclaiming method in a wireless environment we introduce a novel low-power listening technique called *reverse-low-power listening* (RLPL) as part of an overall Hybrid Low-Power Listening (HLPL) protocol. We evaluate our algorithms using Castalia simulator against an oracle-based approach, and show that our dynamic slot reclaiming approach, coupled with HLPL, can introduce substantial power savings without sacrificing real-time support which may be a new approach towards improving industrial wireless standards.

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## 1. Introduction

Industrial network automation systems were traditionally installed with wires connecting communicating devices. Potential drawbacks to purely wired systems are higher costs for cables and maintenance and inflexibility in terms of deploying new nodes or reconfiguring existing systems. As a result industrial automation and control systems are increasingly being supported by wireless networks [1]. Wireless industrial systems are now appearing in application domains such as manufacturing, electrical generation, and chemical refining [2], along with Smart City and environmental monitoring applications [3]. Cur-

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