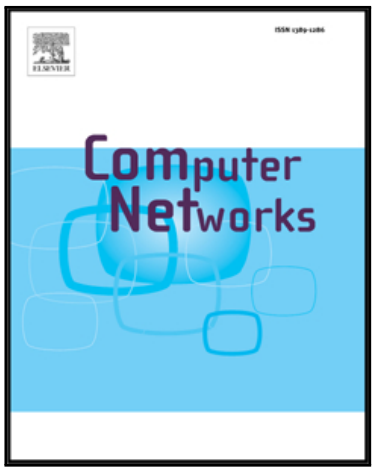

A New Reasoning and Learning Model for Cognitive Wireless Sensor Networks Based on Bayesian Networks and Learning Automata Cooperation

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A New Reasoning and Learning Model for Cognitive Wireless Sensor Networks Based on Bayesian Networks and Learning Automata Cooperation

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Abstract- Adding cognition to existing Wireless Sensor Networks (WSNs) with a cognitive networking approach, which deals with using cognition to the entire network protocol stack to achieve end-to-end goals, brings about many benefits. However cognitive networking may be confused with cognitive radio or cross-layer design, it is a different concept; cognitive radios applies cognition only at the physical layer to overcome the problem of spectrum scarcity, and cross layer design usually focuses on linking at least two non-consecutive specific layers, to achieve a particular goal. Indeed, it can be said that the cognitive radio and the cross layer design are two effective methods in cognitive networking. To the best of our knowledge, almost all of the existing researches on the Cognitive Wireless Sensor Networks (CWSNs) have focused on spectrum allocation and interference reduction in the physical layer. In this paper, we propose a new reasoning and learning model for CWSNs, in which firstly, a team of learning automata is employed to construct a Bayesian Network (BN) model of the parameters of the network protocol stack, and then the constructed BN is used to tune the controllable parameters. The BN represents the dependency relationships between the parameters of the network protocol stack, and the BN-based reasoning is an efficient tool for cross-layer optimization, in order to maximize the perceived network performance. Simulations have been done to evaluate the performance of the proposed model. The results of the simulations show that the proposed model successively adds cognition to a WSN and improves the performance of the communication network.

Keywords- Bayesian Networks; Cognitive Networks; Learning Automata; Reasoning; Wireless Sensor Network

1. Introduction

Wireless Sensor Networks (WSNs) consist of hundreds or even thousands of small devices each with sensing, processing, and communication capabilities to monitor a real-world environment. They are envisioned to play an important role in a wide variety of areas, arranging from critical military surveillance applications to forest fire monitoring [1]. Designing a WSN faces many challenges; here, some of them are mentioned. Usually, the power resource of a WSN is batteries, which are limited and un-chargeable. As a result of power limitation, sensor nodes have low-power radios, which mostly use unlicensed ISM bands (2.4 GHz.), or Wi-Fi, Bluetooth, etc. with the same band. In addition, the performance of WSNs is extremely sensitive to the deployment environment, because the signals of the low-power radios are easily disrupted. Finally, there exist no widely accepted well-performing protocol stacks for these networks, and multiple protocols and multiple parameters might be considered for deployment.

Cognitive radio has emerged as a key technology to solve the problem of spectrum utilization. A cognitive radio is an intelligent wireless communication system that is aware of its surrounding environment, and adapts its internal parameters to achieve a reliable and efficient communication and optimum utilization of the resources [2]. With the advent of cognitive radio technology and cross-layer design [3], Thomas et al. [4] have introduced a different perspective of the traditional networks, named *cognitive network*. Cognitive network is a communication network with a cognitive process