Chapter 45
Distributed Learning Algorithm Applications to the Scheduling of Wireless Sensor Networks

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ABSTRACT

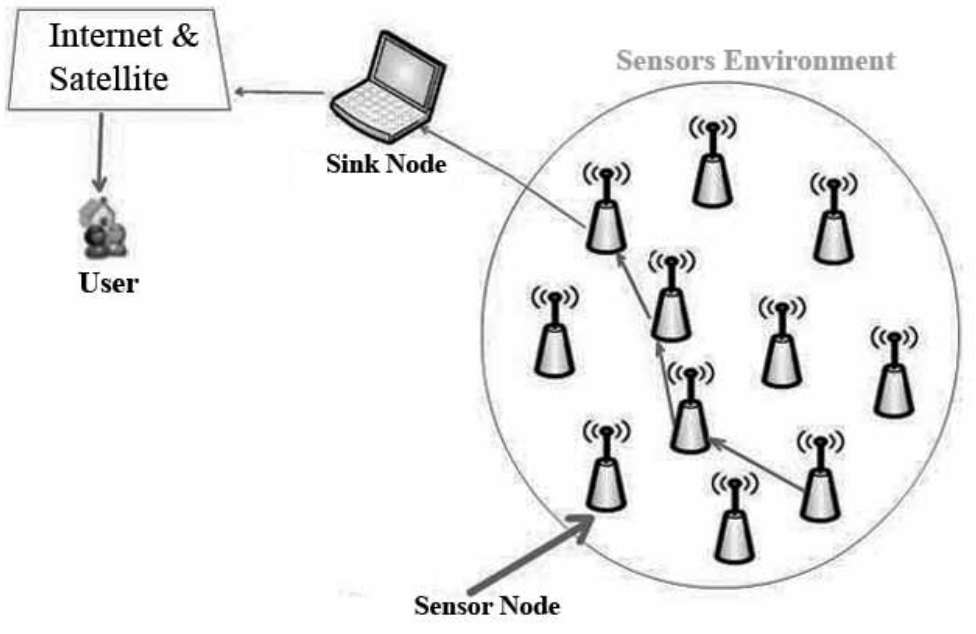
Wireless Sensor Network (WSN) is a network of devices denoted as nodes that can sense the environment and communicate gathered data, through wireless medium to a sink node. It is a wireless network with low power consumption, small size, and reasonable price which has a variety of applications in monitoring and tracking. However, WSN is characterized by constrained energy because its nodes are battery-powered and energy recharging is difficult in most of applications. Also the reduction of energy consumption often introduces additional latency of data delivery. To address this, many scheduling approaches have been proposed. In this paper, the authors discuss the applicability of Reinforcement Learning (RL) towards multiple access design in order to reduce energy consumption and to achieve low latency in WSNs. In this learning strategy, an agent would become knowledgeable in making actions through interacting with the environment. As a result of rewards in response to the actions, the agent asymptotically reaches the optimal policy. This policy maximizes the long-term expected return value of the agent.

INTRODUCTION

Recent advances in electronics and telecommunication create a network of small sensors (nodes) called Wireless Sensor Network (WSN). Wireless sensor networks are a network of devices denoted as nodes that can sense the environment, primarily process it and send it to a central or sink node. It is a distributing and self-organizing network with low power consumption, small size and reasonable prices which has a variety of applications in monitoring and tracking such as military, healthy, industry and so on. Figure 1 presents a communication architecture related to a WSN

DOI: 10.4018/978-1-4666-8751-6.ch045

Figure 1. Communication architecture of a wireless sensor network



(Akyildiz & Sankarasubramaniam, 2002; Yick et al., 2008). Each of these scattered sensor nodes has the capability to collect data (for example temperature, humidity and so on) and transmit it back to the sink node and then send it via web or satellite to the end-users. Of course, it is possible for WSN's node to be classified to some clusters and communicate through the clusters.

Sensor nodes use a battery as the power as shown in Figure 2 (Yu et al., 2006). Since there are many constraints in using of these energy batteries like expensive replacement and charging, the approaches that decrease the nodes' energy consumption are more significant and considerable. One of the main resources of energy consumption in WSNs is radio nodes. A radio node has two separated modes: active and sleep (on and off) modes. Only in the active mode, nodes can receive and transmit data. However a significant amount of energy in a node is wasted by its radio components when it is in the idle listening with no communication activity (Akyildiz & Vuran, 2010).

There are many suggested protocols for WSNs to control and transmit nodes to go to the sleep or active modes. Despite wireless sensor networks are similar to Mobile Ad-hoc NETworks (MANET) from many directions, but the protocols that are used for MANETs are not appropriate to WSNs. An ad-hoc network is a local network that consists of some connected autonomous devices. Instead of being relied on a central station (hub and switch) like typical networks, ad-hoc networks are self-configurable and have the ability to send and receive data between all the nodes coordinately in several steps. Due to the lack of central control, they need a minimum configuration and management costs. Figure 3 shows an example of a wireless ad-hoc network (Abolhasan et al., 2004). Since both wireless sensor networks' and ad-hoc networks nodes use battery energies, their life time is limited to the battery life time. Also their communication types are in kind of wireless channel type, which provides an unreliable communication. In these networks human intervention has been minimized and their configuration is automatically (Perillo & Heinzelman, 2004). Also in terms of network size and nodes number, WSNs node's number is much more than ad-hoc network nodes, (it